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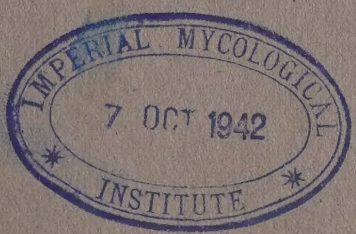

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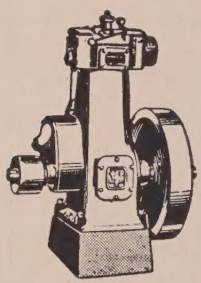

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VOL. 8, No. 2 JUNE, 1942

Organising Agriculture for War

The following majority report, prepared by a sub-committee of the New South Wales branch of the Institute, was adopted at a general meeting of the branch held on 8th May, 1942.

IMPACT OF THE PRESENT WAR.

The outbreak of the second world war marked the opening of a new phase in the history of Australian agriculture. Virtually overnight, export markets for some products were lost, markets for others were created, some problems then current were accentuated, others removed, and still others originated. Hence the war created not only a national crisis but an agricultural crisis, and a new approach to administration was demanded to ensure reorganisation both for a maximum war effort and a much altered post-war economy.

War-time conditions have dictated many changes in production policy. The emphasis, at least until the end of 1941, was on the export of priority foodstuffs and other primary products to the United Kingdom and to Empire and Allied fighting services in the Middle East and in the Far East. The pattern of Australian agriculture was altered, to some extent deliberately, to ensure that the production of essential goods, for example, cheese, oil and fibre plants and drugs, be stepped up, and that unwanted surpluses of, for example, fresh fruits, wheat and wine, were disposed of equitably.

Japanese belligerency has altered the entire farm outlook. First, the menace to the sea lanes to Britain and North America has greatly increased, and it may not be possible to maintain shipments to England of all products in the quantities which have been contracted for. Secondly, growing markets in the Far East, taking produce to the total value of £16,000,000 per annum, have been lost. Thirdly the approach of war to Australian shores and the presence of Allied troops in this country imply both a greatly increased local demand for foodstuffs and a need to accumulate larger stocks in Australia as an insurance against emergency. This may even mean that, although shipping be available, certain foodstuffs will not be exported in quantities for which contracts have been made.

If the time has arrived when we can no longer afford to produce anything which is not essential, then drastic changes in production are necessary. More of some agricultural products will be required ; less of others. One authority has estimated that possibly " wheat production could be cut by some 60 per cent. to 70 per cent., fresh fruit some 50 per cent., and sugar 30 per cent." On the other hand, the production of other major products—notably cheese, bacon and vegetables—and

of several new or minor products—chiefly fibre, oil and drug plants—must be expanded. There are serious limiting factors to such changes. Available manpower, fertilizers, fuel, machinery, seed, and sundry items such as bags and twine, must be considered. Moreover, such aspects as the maintenance of the rural financial structure, of farmers' incomes and of the production capacity of farms must be reviewed.

Clearly, in view of the above considerations, wartime planning is required for agriculture, founded on both practical and technical advice and flexible enough to meet swiftly-changing conditions. Agriculture cannot be expected to adjust itself automatically by the supply-demand price mechanism, either extensively or quickly enough to give the quantities and varieties of production required of it.

Further, for such planning to be effective, it should be developed under the influence of a central authority cooperating with producers' and official organisations in all States. While there are many existing bodies doing valuable work, each in its own sphere, as for example the Australian Agricultural Council and its Standing Committee, the Department of Commerce and the Marketing Boards, State Departments of Agriculture and producers' organisations, there is no special body charged solely with the responsibility of directing the agriculture of the Commonwealth.

If Australian agriculture is not already making a maximum contribution to the requirements of the nation at war, then the shortcomings are due to the deficiencies mentioned above, namely the absence both of deliberate production planning and a central body to direct and coordinate the war on the farm front.

AIMS OF PLANNING A NATIONAL AGRICULTURE.

Planning on a national basis must embrace the formulation of a production programme, the rational use of the restricted rural labour that is now available, and an effort to maintain the incomes of producers and the productive capacity, if not the production, of their properties. Some aspects of these three major aims of planning will be expanded in the following sections.

(1) Production Programmes.

The prime aim of planning agriculture in wartime should be the formulation of a production programme. This implies first, the deliberate assessment of the essential military, civilian and export requirements of each agricultural commodity, and secondly, the devising of means to meet these demands, while allowing for such reasonable surpluses as the uncertainties of war require.

At the present time there is inadequate information on the actual requirements of many primary products. Important steps have been taken to regulate certain industries, but in other industries this much-needed direction is lacking, or production has been considered only on single industry basis and without taking into account the interdependence of various industries upon one another. In other cases the tendency is apparent, as for example in vegetable production, to cater for the needs of the defence forces, while ignoring civilian requirements. Under a planned agriculture, army, civilian and export requirements would be assessed and catered for. In the absence of comprehensive planning, Australian agriculture has failed to mould itself closely to the war needs. This is evidenced by the unwanted surpluses of some commodities such as wheat, lamb and wine, whereas there are serious shortages of other staples such as bacon, cheese, vegetables and dried tree fruits.

A zoned system of production and storage should form a necessary part of a national plan for agriculture, both for the needs of defence, if the war develops unfavourably, and, if it does not, to ease the problems of distribution and disposal which become greater in war time with regard to risk, transport and manpower

demands. A zoned system of production may require a more diversified agriculture in many districts than obtains at present, with safeguards against dumping from other producing centres. A major diversion of production, for example from grain to hay for storage as part of an inland fodder conservation scheme, may be desirable in some zones. In that event it is not equitable that individual farmers should shoulder the financial burden of increasing their fodder reserves far beyond their own requirements.

As part of a zoned system of production, it may become necessary to grow crops in certain localities, although they can be produced more economically elsewhere. Potatoes may be more cheaply produced in Tasmania than in New South Wales; but the shipment of over 50,000 tons annually to New South Wales in war time raises questions of shipping space and risk. Moreover, in the absence of a zoned system of controlled production, the possible flooding of New South Wales markets with Tasmanian potatoes is a serious deterrent to their local production in adequate quantities. This principle has now been recognised to some extent, but only since the industry has deteriorated seriously.

The raising of such essential crops as are deficient at present is one of the urgent adjustments needed of a war-time agriculture. As these crops are required in quantities which may be ascertained, their production throughout the country should be regulated, with satisfactory arrangements as to price and labour supply. Under controlled production, the development of such crops may be highly satisfactory, as has been the increase from 200 acres in 1936 to 60,000 acres in 1941 in the area under flax. The dried grape industry is one which has been developed under control to a state of prosperity, and yet is asking for continued control to avoid ill-considered expansion. Rice is another industry in which control is being exercised so that production will not seriously exceed demand. The success of controlled production in these industries indicates the practicability of extending control to other phases of agriculture.

Adequate surpluses of commodities are needed in war time, but they should not unduly depress the prices of such commodities. An informed national agricultural executive would make itself responsible for assessing demands, maintaining reasonable surpluses and arranging for State quotas of production.

(2) Use of Manpower.

Sufficient manpower should be reserved to carry agricultural programmes into effect. There is now, in certain of the primary industries, an extreme shortage of agricultural labour, and such labour as is available should be conserved for employment in the really essential forms of primary production, and not be expended upon the further production of unnecessary surpluses of certain commodities. Often the manpower situation has been reviewed, after labour shortages have developed and disrupted an industry. This was the case with vegetable production, for which it became necessary to reserve labour for growers who entered into contracts to supply the Defence Foodstuffs Directorate. The reservation of non-contract vegetable growers, however, who supply the civilian requirements, received no attention until the industry had seriously deteriorated. This position is the natural result of not having a predetermined plan, in which manpower requirements, like other agricultural resources, are assessed for a specified output.

To conserve manpower, industries producing in excess of actual requirements may be maintained in a state of productive capacity rather than production. The manpower required to meet this end would be relatively small in many cases. Australia now requires, for example, only six of the eleven million bushels of the apples that are produced annually. If, as the result of survey, the poorest areas were resumed, and the necessary measures taken in others of only medium pro-

ductivity that would keep them in a state of productive capacity, demands for this fruit would be satisfied and manpower released. To this release of manpower from the over-producing industries must be added that freed from the tertiary industries serving them.

(3) Maintenance of Incomes and Productive Capacity.

To the problem of maintaining incomes while reducing production there are three main avenues of approach.

An increase in prices could be made to offset a reduced volume of production. In the case of the wheat industry, a slight rise in price per bushel could be made to compensate for decreased acreage. The price increases could be on a sliding scale, depending on the reduction made. Other methods of compensation could be used where production was eliminated completely.

Alternative forms of primary production represent an ideal solution when local conditions are suitable for the growth of needed products. However, the combined production of essential crops, which at present are not being grown on a sufficient scale in Australia and would grow on typical wheat land, are unlikely to occupy more than a few thousand acres. Because of the high net return from some alternative crops, they may be a more important factor in maintaining incomes in some favoured areas than would appear from the acreage they would occupy. The increased feeding of cereals, both as hay and green fodder, to stock may assist farm incomes not a little. In the rationalisation of the wheat industry, however, major importance is attached to the provision of bonus payments for the conservation of fodder and to the establishment of soil conserving pastures.

Where restriction is necessary, the maintenance of productive capacity rather than production in the industry is a main consideration. Once essential production has been defined, the problem arises of handling the surplus producing areas in a manner which will maintain productive capacity. In the case of much definitely unsatisfactory farming country, its productive capacity as pasture rather than farm lands will need to be considered. In other cases the problems arise of preventing soil erosion and keeping weeds under control, of preventing fences and permanent structures from deteriorating and of keeping machinery in good order. These needs would require considerably less labour, of a less skilled type, than is required for present production. In certain instances it may be feasible to group properties together for a type of cooperative farming, under which a reduced volume of production is permitted to each property. It would thus be possible to carry on with less labour and, providing interest rates were written down on the capital values, farmers continuing in production may continue to enjoy a satisfactory standard of living.

COMMONWEALTH AGRICULTURAL ADMINISTRATION.*

The need for a plan for Australian agriculture calls for the creation of a Federal authority, capable of directing the nation's productive resources. Such an authority could coordinate the activities of various Commonwealth and State departments and could integrate the agricultural policy with the wider national economy in such a way that all sectional interests would be viewed in correct perspective. The direct functions of such an authority may be confined to primary production, but they could logically include also some aspects of distribution and processing of raw materials.

* Since the preparation of this report the Commonwealth Government has announced the establishment of an Australian Food Council. This organisation does not fulfil the functions in the planning of agriculture which it is suggested should be carried out by a Director-General of Agriculture.

To be truly effective, it must have overriding powers, such as would be ascribed to a Director-General of Agriculture. It is well to consider first whether any of the existing Commonwealth bodies are in a position to assume such responsibilities.

The Australian Agricultural Council, and its Standing Committee, are not so constituted as to carry out these functions, and they have not claimed to have assumed them. Members have full-time political or administrative positions elsewhere. The Department of Commerce, together with the Council for Scientific and Industrial Research, is the only Federal organisation represented. Meetings are infrequent and irregular, and the conflicting viewpoints of the States' representatives often delay the reaching of decisions. This is well illustrated in the Council's failure to agree on a wheat stabilisation scheme after it had been under consideration for over a year. Even if equipped with its own research secretariat, which might give the Council or Committee the factual information on which to base a national policy, it appears that the Agricultural Council is better constituted to act as an advisory body to a national executive than an executive body itself.

Coordination is necessary of the agricultural activities of the several Commonwealth Departments, such as War Organisation of Industry, Commerce, Supply, Labour and National Service, and Trade and Customs, all of which, to a greater or lesser extent, are concerned with some aspects of agriculture. The Department of Commerce has become most directly associated with agriculture. However, it has lacked the assistance of sufficient experienced agricultural officers, and, until very recently, does not appear to have attempted to enlist their cooperation. Without such a staff it is incapable of framing a broad plan for agriculture, even if it were interested in doing so.

The Department of Commerce directly influences certain phases of agricultural production through the boards under its control. Such boards, however, represent sectional interests and are concerned only with the welfare of their particular commodities. To operate in the interests of a broad national economy, their activities should be subject to revision by the office of a Director-General of Agriculture, which they may serve in a valuable advisory capacity.

Of other Departments, War Organisation of Industry might be expected to participate largely in the framing of an agricultural policy. However, this Department is already preoccupied with other industries and problems, whereas what is required is an executive body whose sole responsibility is to rationalise and direct Australian agriculture. The Department of Supply is vitally concerned with production, as it furnishes the requirements of the armed forces. As these should no longer be considered apart from civilian needs, it would be more logical for Supply to indicate its requirements to a central authority charged with the responsibility for producing for both army and civilian requirements. This principle has recently been recognised in the case of potato production, and it should be applied without delay also to the vegetable industry as a whole. Labour and National Service, and Trade and Customs are two other Departments the activities of which, as far as they affect agriculture, should be overseen by a Director-General of Agriculture. Close collaboration with the Director-General of Manpower is essential if the labour requirements of agriculture are to be met.

OPERATING A PLANNED AGRICULTURE.

If it be conceded that the present piecemeal approach to the solution of the agricultural problem is unsatisfactory, and that a Director-General should be appointed to act as a central coordinating authority, then it may be opportune to examine what might be the relationships between this authority and the various agricultural organisations. A diagrammatic presentation of one plan of these relationships is given in Figure 1. Assisted by a research secretariat and receiving advice

from four main sources, namely the Australian Agricultural Council, Commonwealth Departments, State Departments of Agriculture, and a producers' council, such an executive would be in a position to formulate a complete and integrated agricultural programme, adaptable to the various contingencies which may arise from the war situation. Such an authority would coordinate the activities of various Commonwealth and State Departments, making the greatest possible use of the numerous organisations that are in existence.

The decisions of the Director-General, after approval by Cabinet, would become binding on the various administrative bodies. Many of these decisions would be logically implemented by State Departments of Agriculture either directly or through State agricultural executives, composed of both departmental and producers' representatives. State Departments of Agriculture have the technical and extension staffs which make them qualified to implement the Federal policy as it affects their own States. In many instances, it would be desirable for the States to have a considerable degree of freedom in adapting a policy to meet State requirements. Thus, in programmes necessitating restriction, quotas could be allotted to the various States, which in turn would allocate them to the various districts.

District control might be vested in local planning groups composed of farmers, often under the chairmanship of the district officer of the State Department of Agriculture. Delegates from the local planning groups might form State producers' councils which, in turn, might be represented on a Commonwealth producers' council. The principle of local planning groups has already worked satisfactorily in the case of the Wheat Stabilisation Plan and could be considerably expanded and made to include all or most aspects of primary production. In both England and the United States, agricultural plans implemented through local executive bodies have achieved considerable success; while, in New Zealand, agricultural planning based on national surveys is far ahead of such planning in Australia.

The various State and Commonwealth farmers' organisations should probably be represented on the State and Commonwealth producers' councils.

Turning now to a consideration of the means by which production programmes may be implemented once they have been decided upon, the methods used to secure the desired direction of production will vary according to the commodity. Production control has already operated successfully in many Australian industries, such as dried grape, rice, sugar and flax. The existing system of contracting to provide vegetables and potatoes for army requirements in some States might well be extended to provide also for civilian requirements under war-time conditions. As part of a general acquisition scheme, it could be utilised to secure adequate, without excess, production as well as to ensure production in strategically desirable areas or in specified zones.

Although effective in the long run, the price mechanism alone appears to be unable adequately to regulate production under conditions of rapid change. This was well illustrated in the case of wheat during the early 'thirties, when falling prices caused farmers to increase their acreages to recoup their prime costs. To stabilise prices, on the other hand, as some boards are attempting to do, is an equally unsatisfactory method of regulating production unless acreages are also controlled, because a satisfactory price will usually cause growers to increase production beyond actual demand. If, however, the price is maintained or even increased while production is decreased, undue hardship in the industry may be avoided. The consumer's interests must, however, also be protected against undue price increases. There is justification and precedent especially under war conditions, for basing prices on costs of production rather than on market value.

If agreements for control of acreages in return for stabilised prices are reached, a plan with regard to the industry has been accomplished in principle. Since planning is involved, other farming operations might readily be incorporated, and

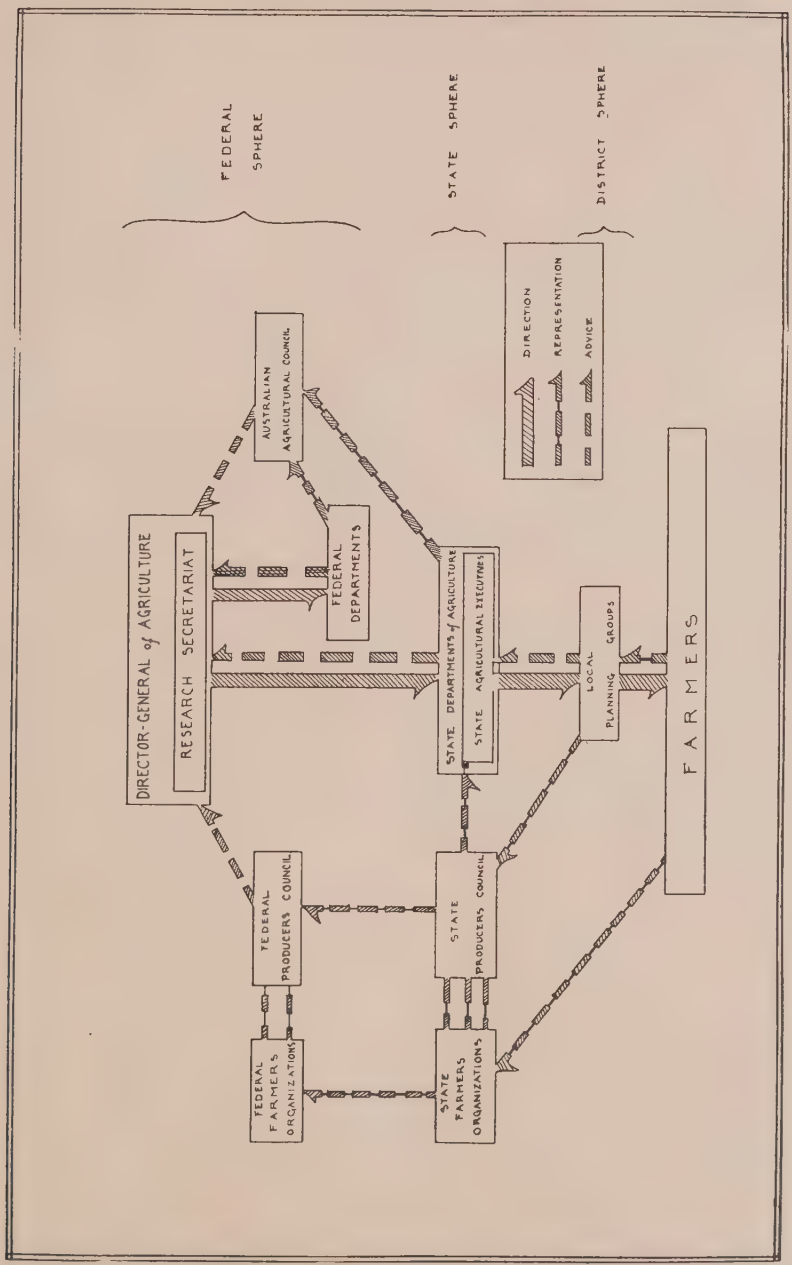
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Figure 1.

the several phases of agriculture being practised in any area might be integrated in the production programme of that area. This would include, where necessary, directing production into those alternative avenues in which additional production is required. The manpower requirements for agriculture should be reserved and, where necessary, protected in order to carry out the plan. In some instances, the reservation of manpower itself might be made the means of directing production.

Most, or all, farmers in all States must subscribe to such a plan for it to function successfully. One of several methods could be adopted to ensure the full cooperation of farmers. It may be necessary, for instance, to discriminate between prices paid to farmers who subscribe to the plan and those who do not. In the case of wheat, for example, there is little doubt that a small bonus payment to farmers subscribing to the restrictions would bring virtually all farmers under a plan without actual compulsion being used. The psychological reaction to compulsion is undesirable, since it leaves with the farmer the impression of a plan being imposed from above. On the other hand a subsidy paid to growers who subscribe to a cooperative movement to restrict production for the common good makes them members of a group, requiring loyalty to the group objective. The group conscience may also assist in the policing of regulations through the exercise of social censures. A number of these principles are embodied in the Federal Government's wheat stabilisation scheme. Again, a system of bonuses, paid, for example, for fodder conserved or areas sown to pasture, may help to direct production along desirable avenues to increase national security and to conserve fertility. Such bonuses need not result in any actual payments being made by the Crown, since the prices at which commodities are bought and sold may be adjusted so as to allow for such payments to be made from the general fund.

It would of course be possible for a producer to enter into separate undertakings with regard to the several commodities with which he was concerned. Simplified administration and better direction, however, are likely to be obtained by each grower entering into a comprehensive agreement which would be ratified by the local planning group, which, in most cases, would be under the direction of the State Department's district representative. A maximum of growers' cooperation will be obtained if farmers, through local planning groups, share the executive responsibility of local control and may officially advise upon the formulation of the central plan and its adaptation to local conditions.

S. L. MACINDOE
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The Food Requirements of Australia in Relation to Primary Production

By

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The production of agricultural commodities to supply the dietary needs of the people living in Australia has become a very urgent problem. To conserve manpower and equipment Australia must produce only those articles of diet which supply these dietary requirements most readily and economically. This paper attempts to assess the food requirements of persons living in, or based on Australia, and to show how those requirements may be met. The food production and requirement figures have been determined as accurately as possible from existing data, but it must be realised that they are only approximate.

The subject can be considered conveniently in four sections, namely, the nature and quantities of the nutritional elements required for adequate health ; the ability of the present primary production to supply these requirements ; the preservation, distribution and preparation of these products ; and desirable trends in general primary production policy in view of the data presented.

Human Nutritional Requirements.

The essential constituents of the human diet may be considered conveniently in their main chemical groups of proteins, fats, carbohydrates, minerals and vitamins.

The energy requirement is usually measured in calories and varies with the individual and the type of work done. These calories may be provided by carbohydrates, proteins or fats, which provide, respectively, 4·1, 4·1 and 9·3 Calories per gram. If certain minimal requirements are met, it is immaterial from what source the calories are supplied, providing the bulk of food is not excessive. This means that with high energy requirements more fat is required in the diet and bulky foodstuffs of low energy value must be reduced. The average man requires 3,000 Calories per day.[16]

The protein intake must satisfy the criteria of both quantity and quality. Clements[3] states that a fair intake is 100 grams per day, of which 50 per cent. should be of animal origin. The quality depends upon the constituent amino-acids, of which man probably requires 9 pre-formed in his diet. Vegetable proteins are often deficient in some of these amino-acids and it is recommended therefore that at least a portion of the protein be of animal origin. In general, as the proportion of animal protein increases, there is a reduction in the amount of total protein necessary to supply the required amino-acids. Meat and milk protein contain adequate amounts of these amino-acids and are called " first-class " proteins. Animal protein products also contain appreciable amounts of minerals and vitamins, especially vitamins of the B-complex, which Waisman *et al.*[23] have investigated.

The quantity of fat required depends on the energy needs. A good daily allowance is 100 grams, of which 25 per cent. should be of animal origin.[16] This allowance may be reduced in an emergency. For adults the fat may be of vegetable origin almost exclusively if fat-soluble vitamins are supplied from other sources. Growing children and nursing mothers may require certain unsaturated fatty acids, which are most readily obtainable from butter.

Carbohydrate is supplied mainly by sugar and cereals. Where the foodstuff contains much cellulose and lignin, only a part of the total carbohydrate, called the available carbohydrate, may be utilised. This is due to the inability of the human alimentary tract to digest fibre in any quantity, the intake of which Pirie[19] recommends should not exceed 15 grams per day.

Calcium is required for the growth of skeletal tissues, for milk production and other body processes. It is present in various food plants but the amount varies considerably with soil, stage of growth and part of the plant consumed. Cereals have a low calcium content, and in some plants it occurs as an insoluble and indigestible salt.[16] Marston and Dawbarn[15] suggest that the intake of calcium should be 1 gram per day.

Phosphorus is widespread in cereals and meats and is unlikely to be deficient in ordinary diets. When present in plants as phytic acid, phosphorus may not be available, and McCollum *et al.*[16] have pointed out that chemical analyses may be misleading. An intake of 1·25 grams per day is sufficient.[15]

Iron is essential for the formation of hæmoglobin and for various cellular enzymatic processes. The retention of iron is very efficient in the adult body and little elimination occurs on iron-deficient diets. MacKey[13] has pointed out, however, that serious deficiencies may occur during periods of pregnancy, lactation or growth, when additional quantities of iron are required. McCollum *et al.*[16] have stressed that some iron present in foodstuffs may not be available for human nutrition. Chemical analyses for total iron, therefore, may be misleading, and consequently the available iron content of foods is quoted. A daily intake of 15 milligrams is recommended by Marston and Dawbarn.[15]

The vitamins fall into two main groups, the fat-soluble group including vitamins A, D, E and K, and the water-soluble group including vitamins C and the B-complex.

Vitamin A is required for the maintenance of the health of epithelial structures. Animals obtain vitamin A from plants in the form of various carotenoid pigments, which act as precursors of the vitamin. Man derives his supply of these substances from land and marine plants, from the former either directly as vegetables, or indirectly and less efficiently by allowing animals to store vitamin A, from the latter in the form of fish liver oils. Land plants supply the greater part of the total amount. Marston and Dawbarn[15] state that 5,000 International Units (I.U.) of vitamin A per day should be adequate.

Vitamin D takes part in calcium and phosphorus metabolism and in normal bone formation. It is formed in the skin by the action of ultra-violet light on sterols, and, in view of the abundance of sunshine to which Australians are exposed, there seems little likelihood of any deficiency occurring.

Vitamin E is associated with reproduction, and is widespread in green plants. The human requirements are very small, and do not warrant further consideration.

Vitamin K is concerned with the clotting of blood. It is also distributed widely in green plants, and is not likely to be deficient.

Vitamin C, or ascorbic acid, is likely to be very important. A gross deficiency leads to scurvy, but a smaller deficiency is associated with the slow healing of wounds and a lowered resistance to infectious agents.[16] As the body stores of the vitamin are quickly depleted,[16] a regular supply is necessary. Vitamin C is widely distributed in plants, especially green vegetables, potatoes, swedes, and certain fruits such as black currants, pawpaws and citrus. However, ascorbic acid is a relatively unstable compound, and is easily destroyed by cooking or by the cell enzymes. Authorities differ widely as to the optimal daily intake, but 100 milligrams is recommended by Marston and Dawbarn.[15]

The vitamins of the B-complex consist of a large number of compounds important in cellular enzyme systems. Some of these compounds have not been identified

while the rôle of others in human nutrition is not yet clear. The most important constituents are vitamin B_1, riboflavin and nicotinic acid. If the requirements of these members of the complex are met, it is unlikely that deficiencies of the other constituents will occur. The B-complex occurs widely in plant products and animal tissues, of which liver and kidney are very rich sources. The daily requirements of the chief constituents are given by Marston and Dawbarn[15] as 600 International Units of vitamin B_1, 1 milligram of riboflavin and 15 milligrams of nicotinic acid.

The nutritional requirements of any individual will depend upon a number of factors, such as age, weight, sex, and type of work. The amounts are increased by pregnancy, lactation and heavy manual work. To make adjustments for these variations when estimating the food requirements of a population, the League of Nations[13] has introduced a system of units based upon the daily energy requirements of an average man doing sedentary work. To simplify the calculations, this system has been extended to include the other dietary constituents, taking the quantities given in the previous section as the requirements of the average man. On this scale the adult male doing sedentary work needs 1 man-unit per day, the adult male doing heavy muscular work 1·5 man-units per day, the adult female 0·8 man-unit per day, the pregnant or lactating female 1·2 man-units per day, and the child under 14 years of age, as an average, 0·7 man-unit per day.

The number of persons in each of these categories has been obtained from the Commonwealth Population Statistics.[4] Based on a population of 7 millions, it is estimated that there will be 1·8 million children under 14 years, 2·6 million adult females, of whom 0·2 million will be expectant or nursing mothers, and 2·6 million adult males, of whom 1·6 million will be doing light work, and 1·0 million heavy work in civilian and military duties. To the last group a further 0·5 million men has been added, making a total population based on Australia of 7·5 millions.

From these figures has been calculated the total number of man-units required per day and per year, namely 7·3 and 2,650 millions, and the annual requirements of the chief dietary constituents, which are given in Table 1.

Primary Production.

The calculations of the production of the chief food constituents are based, with some specified exceptions, on the average annual production during the 5-year period 1935/36-1939/40, as given in the Commonwealth Statistics.[5] It has been assumed that all Australian primary production is available, in the first instance, to meet the food requirements of persons living in and based on Australia. No account has been taken of other export requirements.

The composition of the various commodities has been taken from the data of Marston and Dawbarn[15] and, where these authors give a range, average values have been taken. In a few cases additional information has been taken from Fixsen and Roscoe.[8] The figures for the nicotinic acid content of animal products have been taken from Waisman *et al.*[23] while those for the vitamin B_1 content of wheat flour are from Wardlaw.[24] Due allowance has been made for the inedible portion of certain foodstuffs.[6, 15] It must be emphasised again that these figures are only approximate. The composition of plant products, in particular, varies so much with the soil, the method of husbandry employed, the climatic conditions during growth and the time of harvesting, that it is not profitable to attempt a more accurate estimate of the total production of nutrients. The figures only indicate, therefore, those constituents in which the national dietary is likely to be lacking. Whether deficiencies will develop is a matter for assessment by the medical profession. Such deficiencies may arise from economic causes, from faulty food selection, or from losses in nutritive value occurring during the distribution or preparations of foodstuffs, even when the total primary production is adequate.

The quantities of the chief food constituents provided by the five main groups of primary products are given in Table 1.

Meat Products.

The figures for meat production include the carcases and livers of bullocks, cows, calves, sheep, lambs and pigs. They do not include animals slaughtered privately. The average dressed carcase weights were obtained from the reports of the Sydney Metropolitan Abattoirs for the years 1938/39 and 1939/40. The average liver weights were supplied by the Division of Food Preservation, Council for Scientific and Industrial Research.[9] Allowance has been made for meats condemned as unfit for human consumption by not including kidneys and other offal in the estimate. The production of tallow has not been included in the computation, since it was not possible to determine the proportion of edible tallow.

It will be seen from Table 1 that meat products supply large quantities of protein, fat, phosphorus and vitamins of the B-complex.

Dairy Products.

The total production of dairy products has been obtained from the production figures for liquid milk, condensed and dried milk, butter, cheese and eggs. The production of eggs has been computed by adding exports to an estimate of total consumption, based on an annual *per capita* consumption figure of 11 dozen as given by the Division of Agricultural Economics, N.S.W. Department of Agriculture.[17] Dressed poultry meats have not been included. Table 1 indicates the importance of dairy products in supplying fat, calcium, vitamin A, riboflavin and vitamin C. The calcium and water-soluble vitamins are supplied mainly by milk, whether fresh, condensed or dried, and by cheese.

Cereals and Sugar.

Wheat flour, rice, oatmeal and sugar have been considered. The 5-year average annual *per capita* consumption has been taken as the basis of the estimates for wheat flour and oatmeal. The amounts of these foodstuffs, which might be included in the dietary, have been taken as 1·5 and 1·0 times the annual *per capita* consumption respectively. The production of rice, after allowing for seed requirements, and the total production of sugar, have been used in the estimates. The importance of these products in supplying carbohydrate, minerals and protein is shown by Table 1. Cereals and sugar are very poor sources of the vitamins, except vitamin B_1, which is present in unusually large amounts in Australian wheats.[24]

Fruits.

The majority of the fruits listed in the Commonwealth Statistics[4] has been included in the estimate. The weights per bushel were supplied by the Division of Marketing, N.S.W. Department of Agriculture.[17] From Table 1 it will be seen that fruits supply large amounts of vitamins C and A, and that this is their chief importance in the national dietary. However, the quantities of these vitamins in various fruits varies enormously; they are high in black currants, pawpaws and citrus, and low in pome fruits, especially pears.

Vegetables.

The figures for vegetable production are incomplete, as it has not been possible to determine the production from market gardens and from areas of less than one acre. Adjustments have been made for the seed requirements of potatoes, peas and beans, while it has been assumed that the total production of swedes, turnips and mangolds, much of which is usually fed to stock, is available for human consumption. This assumption tends to compensate for the unavoidable omission of market garden production.

TABLE I.

The Estimated Annual Australian Production and Australian Requirements of the Chief Food Constituents.

	Protein. Tons × 10^3.		Fat. Tons × 10^3.	Carbohydrate. Tons × 10^2.	Calories. × 10^9.	Calcium. Tons.	Available Iron. Tons.	Available Phosphorus. Tons.	Vitamin A. I.U. × 10^{12}.	Vitamin B_1. I.U. × 10^{12}.	Riboflavin. Tons.	Nicotinic Acid. Tons.	Vitamin C. Tons.
	Animal.	Vegetable.											
PRODUCTION—													
Meat products ..	136·2	—	220·7	—	2,613	90	8·5	2,288	0·53	0·86	2·6	98·9	21·9
Dairy products..	44·0	—	216·2	42	2,353	1,342	2·6	395	4·16	0·18	1·9	—	26·0
Cereals and sugar	—	125·5	11·8	1,760	7,811	218	11·8	1,114	—	0·65	—	—	—
Fruit	—	3·2	—	93	738	107	12·8	82	1·73	0·10	0·2	—	81·1
Vegetables ..	—	11·9	2·0	74	368	137	5·7	170	2·88	0·24	0·3	—	134·6
TOTAL	180·2	140·6	450·7	1,969	12,883	1,894	41·5	4,050	9·3	2·0	5·0	98·9	263·6
REQUIREMENTS	132·5	132·5	265·0	1,060	7,950	2,650	39·8	3,312	13·3	1·6	2·7	39·8	265·0
PRODUCTION DEFICIT ..						756			4·0				1·4

The production of *Brassica* spp. is based on data supplied by the Division of Plant Industry, N.S.W. Department of Agriculture,[17] and that of tomatoes on an estimate by the Division of Agricultural Economics[17] of an annual *per capita* consumption of 13 pounds. Pumpkin production has been assumed to be about two-thirds of the total pumpkin and melon production.[5] Table 1 indicates the importance of vegetables in supplying vitamins C and A; 50 per cent. of the total estimated production of vitamin C and 30 per cent. of vitamin A are supplied by vegetables. Certain vegetables, such as cabbage, turnips, swedes, tomatoes and potatoes are good sources of vitamin C, while others such as carrots, tomatoes and yellow sweet potato are excellent sources of vitamin A.[15]

Total Production and Requirements.

The estimated total production of the chief food constituents is given in Table 1. It is apparent that the energy providing elements, protein, fats and carbohydrates, iron, phosphorus and the vitamins of the B-complex are more than adequate to meet the estimated requirements, but that the supplies of calcium, vitamin A and vitamin C are insufficient.

The inadequacy of the supplies of vitamin A and of vitamin C may be greater than the estimates would indicate. Under conditions of deprivation of the precursors of vitamin A, the amount of the vitamin in milk products may be much reduced,[8, 11] while Hart[11] and Underwood *et al.*[23] have shown that a similar change occurs in the vitamin A content of meat products. Hence the supplies of vitamin A from these sources may be expected to be lower than the estimate, when drought conditions reduce the intake of vitamin A precursors by the animal.

It will be seen from Table 1 that, of the total estimated vitamin C production, 50 per cent. is derived from vegetables and 30 per cent. from fruit. In the estimates no allowance has been made for the loss of vitamin C between harvesting and ingestion, although during this period destruction of from 50 to 100 per cent. of the original vitamin content may occur. Considerable quantities of the total fruit production are dried or made into jam, and both of these procedures entail considerable destruction of vitamin C. In the case of vegetables, the losses during distribution and cooking may so reduce the vitamin C content, that only one-half to one-quarter of the estimated production is actually ingested. The reduction of these losses is so important that further consideration is given to this subject later.

Hence it may be concluded that the actual insufficiencies of supplies of vitamins A and C are likely to be greater than those estimated, and that, in view of the necessity for its continuous intake, the insufficiency of vitamin C may be considerable. The calcium supply is also inadequate. This insufficiency may be corrected, either by increasing the consumption of certain primary products, such as milk, skim-milk and cheese, or by fortifying foods with calcium salts.

Distribution, Preservation and Preparation of Foods.

The nutritive value of foodstuffs may be modified greatly by the effects of distribution, preservation and preparation. It is proposed to confine the present discussion to the food constituents in short supply, particularly to the one most subject to destruction between harvest and ingestion, namely vitamin C. For a more complete review the reader is referred to papers by Olliver[18] and by Adam.[1]

Vitamin C is readily soluble in water; it is destroyed by the oxidase enzymes of the intact plant cell[19] and more readily if there is injury to the cell organisation by bruising and cutting; it is destroyed also by excessive heating.[18] To make the most of the supplies available, losses from these causes must be reduced to a minimum.

Effect of Distribution.

Certain green vegetables lose their vitamin C very rapidly after harvesting. This destruction varies with the species and the temperature ; it may be almost complete in 48 hours during the summer in lettuce, silver beet, etc.[9, 15] *Brassica* spp. lose their vitamin C content more slowly.[9] Hence it is essential that green vegetables should be distributed as quickly as possible, or if used for preservation, be treated within a few hours of harvesting. If this is not possible, only vegetable types, such as cabbage, in which the vitamin is destroyed slowly, should be handled.

Root vegetables maintain their vitamin C content much better than green vegetables, but the destruction over a period of months is considerable. Potatoes lose 50 per cent. in one month in earth clamps and 75 per cent. after five months.[18] This loss may be expected to be greater if the tubers are stored at higher environmental temperatures, e.g. in sacks in warehouses. These losses on storage may be prevented by canning immediately after harvesting. However, root vegetables remain a very valuable form in which vitamin C may be stored without elaborate equipment.

Effect of Preservation.

Under certain circumstances the loss during the canning process of the original vitamin C content of fruit and vegetables may amount to 100 per cent.[9] The food value of such canned fruits and canned vegetables depends very largely on their vitamin C content ; the reduction of these losses by approved canning methods is essential. The final product should be in such a form that the whole contents are consumed, as with solid packs or soups. Losses may occur during the initial preparation and blanching ; during the processing, if the temperature is high ; and during storage, either by chemical action or by loss into the liquid portion which is not normally used.[1] The optimal canning conditions, which will provide minimum loss of vitamin C with a good product free from bacterial spoilage, are at present being investigated.[9] Certain vegetables may prove especially suitable, e.g. those in which heat penetration is rapid, causing quick destruction of the cellular enzymes.[18]

An estimate of the vitamin C potency of canned fruits and vegetables has been made by Marston.[14] who expresses his results as man-days, i.e. the number of days for which a 16-ounce can will provide the daily vitamin C requirements of one man. The following is his priority list for canning vegetables, as modified by the Division of Food Preservation, Council for Scientific and Industrial Research[9] :

Tomatoes (solid pack with skins)	..	..	3·7	man-days per 16 oz. can
Potatoes (solid pack)	..	..	1·7	,, ,, ,, ,,
Cauliflower	..	..	1·5	,, ,, ,, ,,
Brussels sprouts	..	..	1·0	,, ,, ,, ,,
Peas (green)	..	..	1·0	,, ,, ,, ,,
Turnips	..	..	1·0	,, ,, ,, ,,
Parsnips	..	..	0·7	,, ,, ,, ,,

Other vegetables and most fruits available for canning give a product containing less than 0·7 man-unit per 16-ounce can, which is considered the minimum content compatible with the efficient use of existing tin plate supplies.[14]

In the usual method of canning vegetables and fruit, a considerable proportion of the final product is water. If these commodities were dehydrated prior to canning, the food value per 16-ounce can would be increased greatly. The dehydration of vegetables without appreciable loss of vitamin C content is difficult, since the cutting of succulent vegetables necessary for rapid drying hastens the enzymatic destruction of the vitamin. Cabbages have been dried successfully on an experimental scale.[9]

However, alternative sources of vitamin C might be considered, especially vegetable products with a thin leaf which desiccate easily. Such sources are young lucerne and young grass,[15, 16] or young growing cereal plants.[2, 15] In addition these products are very rich in the precursors of vitamin A and in protein. They wilt easily after cutting and the initial dehydration might be carried out with sun heat in the field, although this procedure causes some loss of vitamin A precursors.[10] Such loss is reduced if special methods of grass drying are used.[25]

Effect of Preparation.

Considerable losses of vitamin C through leaching, enzymatic oxidation and heat destruction may occur during the preparation of foodstuffs for the table. These losses in the case of vegetables are greater with green than with root vegetables, and may amount to over 90 per cent. of the original vitamin content. To minimise these losses, Olliver[18] recommends the following guiding principles :

1. Vegetables should be used as soon as is practicable after harvesting.
2. Waste in preparation of vegetables should be reduced to a minimum, and, with green vegetables, only tough stems and badly wilted leaves should be removed. Root vegetables should be cooked either very thinly peeled or unpeeled.
3. Green vegetables should be boiled rapidly for the shortest possible time in the minimum amount of water. The cooking liquor should be used for soups and gravies.
4. Root vegetables can be boiled, steamed, baked or fried, but as with green vegetables excess cooking is to be avoided.
5. " Keeping hot " of cooked green or root vegetables should be avoided most rigorously.

The Direction of Primary Production Policy.

It has been shown that the existing primary production is not sufficient to supply the estimated requirements of vitamin A, vitamin C, and calcium, while the production of protein, fat and carbohydrate is in excess of requirements. In view of these findings certain changes in agricultural production policy appear to be desirable.

Fruit and Vegetables.

Since fruit and vegetables are the major sources of vitamins A and C in the national dietary, the maintenance and extension of existing production is very necessary. The anticipated production deficit must be corrected by increasing the total annual production, by reducing losses during distribution, and by ensuring continuity of supplies, while keeping the requirements of manpower and equipment to a minimum.

To increase the total annual production, existing supplies must be maintained, while additional production of plants rich in vitamins A and C must be developed. This can be done quickly either by extending the acreage in vegetables, especially *Brassica* spp., or by introducing products not normally used as human food. The former is already being carried out under irrigation in New South Wales. The latter has not been developed hitherto and requires further consideration.

Certain young graminaceous and leguminous plants are very rich sources of vitamins A and C, but they are not utilised for human consumption directly ; it is more usual to convert them into animal products. This method is not very efficient, and young grass and lucerne may be used directly. The chief problems are those of palatability and of fibre content. The former may be overcome if the product be dried, ground and incorporated in small amounts in soups and other dishes, while the

fibre content may be kept low by harvesting the material during the early stages of growth when the contents of both vitamin A and C are highest. Such a product has been produced commercially but thus far has been used chiefly as a special food rather than as a regular article of diet. A further valuable nutrient in dried lucerne and grass is the protein, which is of high quality.[19, 20]

The direct use of young lucerne and grass to increase the supplies of vitamins A and C may be a more suitable method than trying to extend the large scale production of vegetables, for the successful growing of which men with special knowledge are required. The number of experienced men able to grow lucerne and grasses for drying would be much greater, and special equipment needs are less likely to be a limiting factor in production. The rapid drying of young lucerne and grass does not require further cutting after harvesting, and hence the loss of vitamin C may be less than with bulky vegetables. This drying could be done without elaborate equipment by using sun-heat in the fields, or, with less deterioration, by using agricultural grass-drying processes.[25]

To reduce losses in distribution, production of vegetables should be near the consuming areas and canning factories. Every district should aim to be self-sufficient, so that shipment of green vegetables especially through metropolitan areas, may be avoided. A more efficient use of available supplies by the housewife could be encouraged by disseminating through the radio and the press the principles recommended by Olliver.[18]

To ensure the continuity of supplies a coordinated production plan is necessary with storage of supplies to tide over periods of inadequate production. Such storage may be in the form of preserved products, or more simply in the form of root vegetables, non-perishable fruits, dried legumes and grains. These legumes and grains may be germinated, when large amounts of carotene and smaller amounts of vitamin C are synthesised by the sprouted seed. Pulses and legumes are probably the best seeds for this purpose.[2, 15]

To conserve manpower and equipment, the continued production of certain fruits and vegetables in which vitamin A and C contents are low, as in pears, apples and beetroot, or very readily destroyed, as in silver beet tops, should be examined with a view to using such manpower and equipment more efficiently.

Finally, the most effective way of saving manpower and facilities in supplying these nutrients is to encourage the production of vegetables in home and community gardens, a method which was widely used in Britain in the last war, and is being developed greatly during this war.[21, 22] Community gardens, known as allotments, are a regular feature of most British towns. There are some in Australia; there seems considerable scope for their further development in areas of good rainfall.

Dairy Products.

The total estimated production of dairy products is more than sufficient, but a large proportion is converted into butter. Yet the total estimated production of fat from all sources is 75 per cent. above estimated requirements, while calcium supplies are insufficient. Milk is an excellent source of calcium, but the production of butter means the loss of this mineral, and also of the water-soluble vitamins, losses which may be recovered in a small way by pig feeding. Such a method is inefficient, and the calcium should be made available for human consumption directly. To do this a larger quantity of the milk produced should be consumed as milk, either fresh, condensed or dried, and as cheese, while the proportion of the total production converted into butter should be reduced.

Meat Products.

Since the total estimated production of the main food constituents supplied by meat products, namely, animal protein, fat, phosphorus and vitamins of the B-complex, is considerably in excess of estimated requirements, the production of meat products could be reduced considerably, if the demands of persons based on Australia have to be supplied only. However, export requirements and the recent unfavourable conditions in the industry may modify the position. If it is found necessary to encourage the production of animal protein and fat, conversion of the cereal surpluses should be considered. Of such material the percentage converted into edible product amounts to 18 per cent. as milk, 15 per cent. as pig meats, and about 3 per cent. as beef and mutton.[11] Hence to employ cattle or sheep to convert high grade cereal products into meat products is not efficient. Such products should be used for milk or pig meat production. The feeding of wheat in large quantities to dairy cows raises certain nutritional problems. In addition there are difficulties in increasing the cow population quickly and in transporting wheat to the dairying districts, where the necessary equipment is available for handling milk production.

The more effective way of utilising cereal surpluses is to convert them into pig meats. The pig population may be increased more rapidly than any other animal population. The raising of pigs does not require extensive equipment and the industry could be established in the cereal growing areas, thereby introducing an alternative source of revenue. Such an expansion of the pig industry needs very careful planning and organisation, with safeguards against such sudden fluctuations in demand as have occurred recently with disastrous results. The efficient use of these cereals would be enhanced if protein concentrates such as meat and blood meal were made available to supplement the cereal ration.

Summary.

1. An estimate of the food requirements, in terms of the main nutritional constituents, has been made for all persons based upon Australia.

2. An estimate of the supply of these food requirements calculated on the production for the five years 1935/36-1939/40 has been made.

3. It is shown that the estimated total production will supply amounts of protein, fat, carbohydrate, iron, phosphorus and the vitamins of the B-complex in excess of estimated requirements, but that the supplies of vitamin A, vitamin C, and calcium are likely to be insufficient.

4. The losses of nutrients, particularly of vitamin C, from foodstuffs during distribution, preservation and preparation are considered, and means by which such losses may be reduced are discussed.

5. It is concluded that, in order to supply the estimated food requirements of persons based on Australia only, primary production should be modified in the following ways:

The commercial production of certain vegetables should be extended and the cultivation of home and community gardens should be encouraged by every possible means.

The direct utilisation of young lucerne and grass as a human food should be investigated.

The production of cereals and sugar could be reduced.

The utilisation of dairy products should be modified so that more milk, either fresh, condensed or dried, skim-milk and cheese are available.

The production of meat products could be reduced. If other considerations make an increase of production necessary, an expansion of the pig industry in the cereal growing areas is recommended.

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The Economic Approach to Dairy Cow Rationing

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The economic approach to dairy cow rationing is mainly an extension matter, the fundamental principles having been available, though not widely used, for many years. Despite the obvious importance of the subject, it has not yet received the attention it deserves in extension publications or even in the standard nutrition textbooks.

The economic approach rests upon the interchangeability of feeds and the fact that the cost of individual feeds is not determined to any marked extent by their relative feed values. A wide range of feeds can be used to make up satisfactory dairy cow rations. As prices rise and fall one food or another becomes the best buying. Good feeding, in the sense of profitable feeding, is not simply a matter of discovering a ration on which the cows will milk well, and adhering to it through thick and thin. It is a matter of continuously using those feeds which happen to be the best value at the time of purchase. On the one hand, the aim is merely to ensure good yields ; on the other, it is to maintain the maximum margin between costs and returns. Many of the " practical " objections to individual feeds are merely instances of wrongful use. Many of the special virtues claimed for other feeds can be explained by the fact that they are foolproof ; bran is a typical example. This paper is an attempt to set out the broad principles of the economic approach and its implications.

Method of Approach.

Successive steps in building up the most economic ration are :

(1) Divide the available feeds into four major classes, according to their uses :

- (*a*) Roughage.
- (*b*) Starch-rich concentrates.
- (*c*) Protein-rich concentrates.
- (*d*) Self-balanced feeds.

(2) Calculate which feed represents the best value in its class.

(3) Combine the feeds of best value in those proportions which yield sufficient roughage, energy, and protein for the needs of the cows.

(4) Make minor alterations, if necessary, in the concentrate mixture to improve its physical texture and palatability.

The first step immediately raises the problem of suitable criteria for subdivision and comparison of values. Feeds are compared by the cost per calorie, pound of starch equivalent, pound of total digestible nutrients, or pound of protein equivalent. The final choice is immaterial, subject to the restriction that the selected standards should be confined to those classes to which they legitimately apply. Each standard appears to be sufficiently accurate for field use in the hands of the man who is familiar with it. Decimal distinctions do not count for a great deal in actual feeding. It is more convenient to measure feeds by volume than by weight. Such a method plays havoc with attempts at exact feeding. Much of the criticism levelled at the various standards, such as the starch equivalent, is the result of attempts to claim too much for them. The starch equivalent, for instance, is a fair and useful means

of comparing starchy concentrates among themselves. It breaks down as a means of comparing the starchy concentrates exactly with the roughages because the latter are more useful to the animal in winter than in summer. Yet the starch equivalent is probably a reasonable measure for comparing one roughage with another.

The logical criterion for the protein-rich feeds is the protein equivalent. This has a minor weakness in that it fails to allow for differing energy contents. The fastidious can make a suitable correction by reckoning in the differences at the equivalent cost of the additional energy in the form of the cheapest starchy feed. The use of the starch equivalent to compare the grains with the protein-rich feeds or to compare the protein-rich feeds with one another is liable to give misleading results.

Normal Unit Values.

Another aspect of the comparison of feeds calls for mention at this stage, namely, the economic importance of each of the four suggested subdivisions of feeds within the ration. From a nutritional point of view roughage is required as a filler and also as a limited source of energy and protein. If a cow be fed on concentrates only, she ceases to ruminate. Nevertheless she can be kept alive and in milk on such a diet. Unless roughage of exceptionally high feeding value be available, an all-roughage ration will not provide more nutriment than will keep the cow alive and yield one gallon of milk a day. The nutritional rôle of the feeds in subdivisions (*b*), (*c*) and (*d*)—the concentrates—is to make the ration rich enough for a higher level of production than a gallon a day.

From the economic point of view the justification for roughage in the ration—and this applies almost exclusively to home-grown roughage—is its low cost per pound starch equivalent. A " normal " production cost for home-grown roughage is ½d. a pound starch equivalent. This is equivalent to 11s. a ton for silage and 33s. a ton for hay. Various departmental estimates of hay and silage costs agree fairly closely with these levels. The corresponding " normal " for grains, which are the main constituents of the most economical concentrate mixtures and which, therefore, dominate the cost, is 1d. a pound starch equivalent. This is equivalent to 3s. 7d. a bushel for wheat and maize, 3s. for barley, 2s. for oats, and £5 16s. 8d. a short ton for pollard. It is interesting to note that the same relationship in cost between home-grown roughage and the grains exists in the United States of America (Yearbook of Agriculture, U.S. Department of Agriculture, 1936, page 111).

Purchased roughage, however, can rarely be landed on the buyer's farm, even in slump periods, at much less than 50s. a ton. At 66s. a ton, which is still a fairly low landed cost for purchased roughage, it is as dear per pound starch equivalent as grain. At the time of writing (May 7, 1942), oaten hay is £10 a ton at Alexandria market, Sydney. This is equivalent to 3d. a pound starch equivalent. A " normal " landed cost for purchased roughage is probably about 1½d. a pound starch equivalent, or £5 a ton.

The phrase " as dear as grain " requires further explanation : it implies that grain is stable at 1d. a pound starch equivalent. This is not always true for every grain, but almost every year one grain or another is down to the base price levels previously quoted. This attempt to compare grain with roughage does not conflict with an earlier statement that such comparisons are not legitimate ; the present comparison is in a broad sense only.

Economic Structure of Rations.

The foregoing figures enable one to piece together the simple economic structure of the dairy cow's ration. A 7-cwt. Jersey requires 5 lb. starch equivalent for maintenance and 3 lb. starch equivalent for each gallon of milk. When home-grown roughage is available at ½d. a pound starch equivalent, the maintenance cost of such a cow is 2½d. a day if the quantity of roughage be just sufficient to meet the maintenance needs. If the cow gives two gallons a day, her production requirements will be 6 lb. starch equivalent. If the cost of concentrates is 1¼d. a pound starch equivalent, a price which should cover the expenditure on mixing, grinding, and the increase due to the addition of a protein supplement, the concentrate cost per gallon is 3¾d. The total cost of feeding the cow, therefore, is 10d. a day, an average of 5d. a gallon.

Contrast this cost with that of the dairy farmer whose roughage reserves are exhausted and who is compelled to buy hay at £10 a ton. The maintenance cost of a 7-cwt. Jersey on such feed would be 1s. 3d. a day. If concentrates remained at 3¾d. a gallon, the total feed cost would be 1s. 10½d. a day, which equals 11¼d. a gallon.

Importance of Roughage Costs.

In practice, the cost of roughage rather than the cost of concentrates determines the economy of hand-feeding—not because roughage regularly forms the major item of cost in the feed bill, but for the reason that the range of variation in cost, from the home-grown to the highest-priced purchased supply, is so much greater in roughage than in concentrates. The dominating effect of roughage costs upon the profits to be made out of hand-feeding is, of course, the real reason for fodder conservation on the dairy farm. If home-grown roughage at ½d. a pound starch equivalent be available, and if concentrates can be obtained at less than 4½d. a gallon, even the butter-factory supplier receiving from 7½d. a gallon upwards can use concentrates with profit. If both roughage and concentrates must be purchased and the prices for each are about the normal levels, that is, 1½d. and 1d. respectively, only the city supplier receiving 1s. 2d. to 1s. 4d. a gallon has a satisfactory working margin.

Selecting Cheapest Feeds.

In making up rations the three primary requirements are sufficient roughage, energy, and protein. From the economic point of view the " best " ration would be made up from the cheapest sources of each. If no home-grown roughage be available, the purchasable lines should be compared on the cost per pound starch equivalent. This is probably a counsel of perfection. We lack Australian figures for these feeds. Further, the roughages are likely to vary to a greater extent than the grains from the values given in the tables.

The feeder has a choice of two kinds of concentrates :

(1) A mixture of the cheapest grain and the cheapest source of protein.

(2) The cheapest of the self-balanced feeds—bran, maize gluten feed, and coconut meal.

Selection of the cheapest grain is straightforward, namely, by comparing the cost per pound starch equivalent :

$$\frac{\text{Price per bushel}}{\text{Weight per bushel}} \times \frac{100}{S.E.}$$

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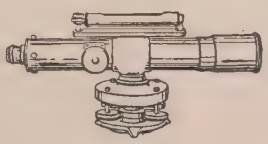

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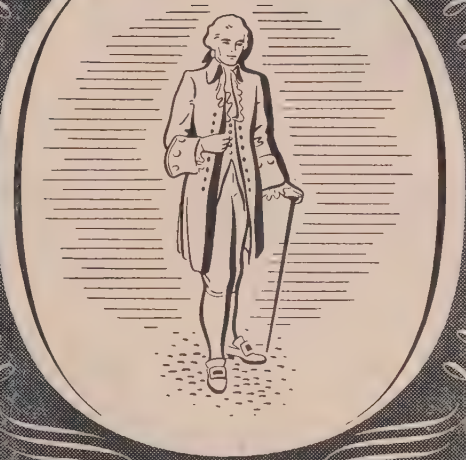

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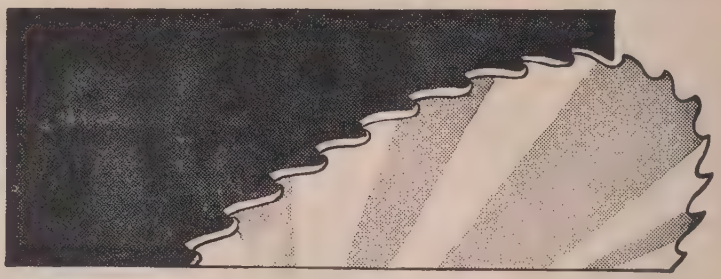

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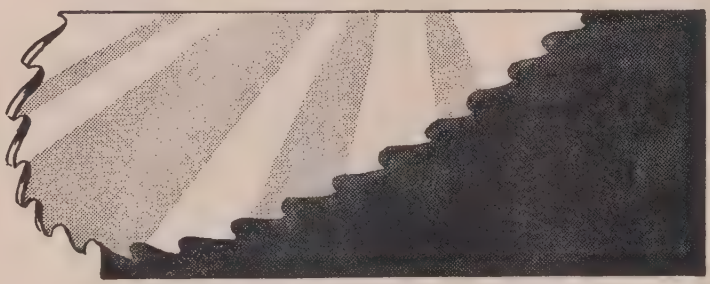

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any individual feed. By combining these three it is possible to calculate a series of divisors which give the cost per pound starch equivalent by simple division into the bushel price. These divisors are : wheat and maize, 43 ; barley, 36 ; oats, 24 ; and pollard, 14. The writer has constructed a circular slide rule using these factors.

The protein equivalent in itself forms a simple divisor for quickly arriving at the cheapest form of protein.

The self-balanced feeds are those with a ratio of starch equivalent to protein equivalent of between 4·5 to 1 and 5 to 1, which is the same ratio as the productive portion of the ration. These feeds can be legitimately compared on either starch equivalent or protein equivalent ; each ranges the feeds in the same order.

Once the cheapest mixture of grain and protein-rich feed has been calculated, there remains the question of comparing its unit cost with that of the cheapest self-balancing feed. The average starch equivalent of the mixture and that of the selected self-balanced feed are suitable criteria.

Balancing Rations.

So far only casual mention has been made of the " balance " of the concentrate mixture. Balance is important from the economic as well as from the nutritional points of view. Both the supply of energy and the quantity of protein can limit production. An excess of either is wasteful. Excess energy is of no avail if the required amount of protein be lacking. Excess protein, though available as energy, is a costly way of supplying this requirement.

The standard method of determining balanced rations is by trial-and-error. A quicker and more direct method is to use the following algebraic formula :

Let a equal the weight of dry matter in the roughage.
" b " " starchy concentrate.
" c " " protein-rich concentrate.
" $S.E.$ equal starch equivalent and $P.E.$ equal protein equivalent.

Then

$a+b+c$=dry matter capacity of the cow.
$S.E_a.a+S.E_b.b+S.E_c.c=S.E.$ requirement of cow.
$P.E_a.a+P.E_b.b+P.E_c.c=P.E.$ requirement of cow.

This is a straightforward simultaneous equation with three unknowns. Solve for a, b, c.

When all the feeds are of about the same dry matter content—that is, when no silage is included—a, b and c can represent pounds of feed instead of pounds of dry matter without serious error. $a+b+c$ will then equal the appetite of the cow in pounds of feed.

Example.

A Jersey cow of 800 lb. live weight gives daily three gallons of milk with a 5 per cent. butter fat content. The cheapest sources of roughage, grain and protein respectively are oaten chaff barley and peanut meal.

Requirements :

	S.E. lb.	P.E. lb.
Maintenance	5·0	0·5
Production	9·6	2·34
Total	14·6	2·84

COMPOSITION OF FEEDS :

	S.E. per lb.	P.E. per lb.
Oaten chaff	0·42	0·035
Barley	0·71	0·068
Peanut meal	0·78	0·42

Let a = number of pounds of oaten chaff.
" b = " " " " barley.
" c = " " " " peanut meal.
Capacity of cow = 25 lb. feed.

Then

$$a + b + c = 25{\cdot}0 \text{ lb.} \quad (1)$$
$$0{\cdot}42a + 0{\cdot}71b + 0{\cdot}78c = 14{\cdot}6 \text{ lb.} \quad (2)$$
$$0{\cdot}35a + 0{\cdot}068b + 0{\cdot}42c = 2{\cdot}84 \quad (3)$$
$$0{\cdot}78a + 0{\cdot}78b + 0{\cdot}78c = 19{\cdot}5 \quad (4)$$
$$0{\cdot}42a + 0{\cdot}71b + 0{\cdot}78c = 14{\cdot}6 \quad (2)$$
$$0{\cdot}36a + 0{\cdot}07b = 4{\cdot}9 \quad (5)$$
$$0{\cdot}42a + 0{\cdot}42b + 0{\cdot}42c = 10{\cdot}05 \quad (6)$$
$$0{\cdot}035a + 0{\cdot}068b + 0{\cdot}42c = 2{\cdot}84 \quad (3)$$
$$0{\cdot}385a + 0{\cdot}352b = 7{\cdot}66 \quad (7)$$
$$0{\cdot}385a + 0{\cdot}352b = 7{\cdot}66 \quad (7)$$
$$0{\cdot}385a + 0{\cdot}075b = 5{\cdot}25 \quad (8)$$
$$0{\cdot}277b = 2{\cdot}41 \quad (9)$$
$$b = 8{\cdot}75 \text{ lb.} \quad (10)$$

By substitution in (5) :

$$0{\cdot}36a = 4{\cdot}9 - 8{\cdot}75 \times 0{\cdot}07 \quad (11)$$
$$a = 11{\cdot}9 \text{ lb.}$$

By substitution in (1) :

$$c = 4{\cdot}35 \text{ lb.} \quad (12)$$

RATION :

11·9 lb. oaten chaff.
8·75 lb. barley.
4·35 lb. peanut meal.

The equation can be adapted to any number of ingredients. These additional feeds are likely to be included to give variety, to improve the texture, or to make the ration more palatable. They will, of course, fall into one of the four major subdivisions quoted previously. The actual proportion of any such ingredients will generally be determined arbitrarily in advance. For instance, the feeder may decide to include both wheat and barley, say, in the proportions of one part of wheat to two of barley. If "b" represents the quantity of any one grain in the ration, and "y" the percentage of the other grain, the appropriate equation will be :

$$a + b + c + \frac{by}{100 - y} = \text{appetite.}$$

$$S.E_a.a + S.E_b.b + S.E_c.c + S.E_y.\frac{by}{100 - y} = S.E. \text{ of ration.}$$

$$P.E_a.a + P.E_b.b + P.E_c.c + P.E_y.\frac{by}{100 - y} = P.E. \text{ of ration.}$$

The term $S.E_y.$ signifies the starch equivalent of the other grain. $P.E_y.$ is the corresponding term for the protein equivalent.

The actual quantity of the "other" grain is given by substitution in the term $\frac{by}{100 - y}$ after the equation has been solved for b.

If two sources of protein are to be used, the appropriate changes in the equations are similar to those for grain. The quantity of the second source of protein would be $\frac{cz}{100-z}$ where z=the proportion of the second source of protein expressed as a percentage of the total quantity of protein-rich feed.

An equation covering two roughages, two grains, and two sources of protein would be :

$$a+\frac{ax}{100-x}+b+\frac{bx}{100-x}+c+\frac{cz}{100-z}=\text{appetite of cow.}$$

$$S.E_a.a+S.E_x.\frac{ax}{100-x}+S.E_b.b+S.E_y.\frac{by}{100-y}+S.E_c.c+S.E_z.\frac{cz}{100-z}=S.E.\text{ of ration.}$$

$$P.E_a.a+P.E_x.\frac{ax}{100-x}+P.E_b.b+P.E_y.\frac{by}{100-y}+P.E_c.c+P.E_z.\frac{cz}{100-z}=P.E.\text{ of ration.}$$

A quicker and simpler method of dealing with complicated rations is to work out the average starch equivalents and protein equivalents of the roughage, grain and protein-rich feeds separately and use the $a+b+c$ equation, letting a equal the quantity of roughage of all kinds, b equal the quantity of grain of all kinds, and c equal the quantity of protein-rich feeds of all kinds.

If the additional ingredient be a self-balanced feed, work out the ration without including that ingredient in the calculations, and add the desired proportion of it to the concentrates afterwards. The addition of a self-balanced feed does not, of course, alter the final balance of the concentrate mixture.

Texture and Palatability.

One major objection can be raised to the rationing scheme advanced in this paper : that such rigid adherence to the cost per pound of starch or protein equivalent will not always yield a ration of satisfactory physical texture and palatability. That is quite true. The remedy is to work out the basic ration first and to make the adjustments necessary to improve texture and palatability afterwards. In this way the essential economy of the ration is preserved. In general, the replacement of one-fourth to one-fifth of the concentrate mixture by an equivalent weight—not an *equal* weight—of bran will serve this purpose. If oats constitute one-quarter of the mixture, it will generally be of satisfactory texture. The choice between oats and bran can be decided again on relative costs. The two, however, are not simply interchangeable. Oats will require to be supplemented by some protein-rich feed. The use of bran as a leavening and flavouring agent is probably the limit of its economy in dairy cow feeding. As the sole or principal supplement to roughage—and it is widely so used—bran is a costly feed. Its replacement by grain and a protein supplement can sometimes effect economies of up to 2d. a gallon in the cost of milk production.

Applications of Economic Approach.

The economic approach to dairy cow rationing has extensive and immediate applications. It lends itself particularly well to extension work. Preliminary surveys around Sydney, for instance, suggest that it would not be difficult to reduce the average metropolitan supplier's feeding costs by up to 3d. a gallon. In one instance an improvement of £40 a week in the owner's financial position could have been effected.

The emphasis on the importance of roughage costs, which results from the economic approach, raises the question as to whether concentrate feeding would pay on farms which supply butter factories and which normally have home-grown hay or silage as the chief winter feed. The normal feeding sets a production limit well below the capacity of the autumn calvers at least. Each extra gallon is worth from 7½d. upwards, depending upon the butter fat test and the returns from the skim milk fed to pigs. The concentrates to produce it can be purchased for about 4d. or, at the most, 5d. This additional milk carries little in the way of overhead.

One of the provocative possibilities suggested by the high cost of roughage around Sydney is the feeding of cows on concentrates only or, at least, on small quantities of hay plus concentrates in sufficient amount to provide the full maintenance and production requirements. If, for instance, an Ayrshire cow giving three gallons a day could be kept satisfactorily on 4 lb. hay plus concentrates, and if feeds were purchased at the prices ruling in Sydney in April, 1942, a reduction of 3d. a gallon in the cost of milk from that cow could be effected. A limited amount of work on all-concentrate feeding has been done overseas, but with a physiological rather than an economical end in view. We have kept a cow in milk for three months on maize and peanut meals only. Although we encountered several difficulties, the results were sufficiently encouraging to warrant an extension and continuation of the investigation.

There are pitfalls in the purely economic approach to dairy cow rationing. Any scheme which disregards the fact that the cow is a biological organism and seeks to put her on the unvarying plane of efficiency of the machine, is likely to break down. The old steam engine analogy is not yet out of date; a lot depends on the stoker. Yet the economic approach, properly adapted, has a useful contribution to make to dairy cow feeding.

(Received for publication, 22nd May, 1942.)

TECHNICAL NOTES

TWO SPRINGTAILS (COLLEMBOLA) OF MEDICAL INTEREST.

The large natural order Collembola contains many insects of economic importance as well as a larger number which are purely of taxonomic interest. The species of economic importance are, in the main, phytophagous, feeding upon the foliage of plants. Perhaps the species best known in this respect in Australia is the clover Springtail *Smynthurus viridis* L., present in many pastures in Western Australia, South Australia, Victoria, Tasmania and New South Wales.

However, very little record exists of Collembola being of medical importance. The species *Achorutes viaticus* L. has been found[1, 2] to play a very definite rôle in keeping free from slimy growth the interstices of sewage filter beds, which otherwise demand frequent laborious cleaning. Apart from these records, the group as a whole appears to have been of little medical interest.

Over the past three years, two instances of these insects causing trouble to human beings have come under the writer's notice, and are reported herein.

In 1939, specimens of springtails were received from a Melbourne specialist who stated that they were causing skin troubles on a female patient. The insect

in question was the species *Entomobrya multifasciata* Tull., a European species originally described in 1871, but which is now cosmopolitan in its distribution. Womersley[3] records it as being common in cultivated areas in the Australian States. The symptoms of this case were as follows : the patient experienced a sharp biting sensation, followed by intolerable itching. There were few marks on the body with an occasional excoriated papule, while the irritation was distributed fairly generally over the trunk and limbs, but was most marked around the waist. Several specimens of the insect responsible for the condition were found on the patient's body. She received no active treatment, but her clothes and bedclothes were sterilised and this was sufficient to destroy the insect and thereby remove the irritation.

On considering the origin of this infection, it appeared that the patient had recently moved into a new house where the garden was in the process of being made. The insects had apparently migrated to the patient when the grass, weeds and soil outside were disturbed.

In 1941, specimens of another springtail were received from a military hospital in Victoria, where skin irritations were occurring among the nursing staff. The species concerned was *Entomobrya tenuicauda* Schott., a native insect originally described in 1917 from Queensland, later recorded by Womersley[3] from Western Australia and Tasmania, and now from Victoria. In this instance, the presence of the insect produced on several nurses raised lumps very similar to mosquito bites, and which later were very irritable. In one instance there was also a good deal of reddening of the calf of the leg. These conditions lasted for somewhat less than twenty-four hours in each case, but reoccurred the next day, probably from more " bites ".

On analysing this case, it appears certain that the insects were introduced into the hospital with flowers, and from there moved on to the affected nurses during their normal routine duties.

In discussing these cases later with H. Womersley, Entomologist of the South Australian Museum, who kindly identified the above species, he suggested that in all the members of the genus Entomobrya, the long ciliated hairs present on the insect are easily detached, and would undoubtedly cause skin irritations. It is doubtful whether this explanation is sufficient to meet these cases, as the actual effect described was that of a distinct biting sensation such as would be experienced if the skin had been penetrated by the mouth parts of the insects.

It appears therefore, that certain species of Collembolan insects are capable of causing severe skin irritations on human beings, and therefore must be considered of some medical importance. Typical symptoms are a biting sensation, followed by intense irritation and the production of small pimple-like bodies.

R. T. M. Pescott.

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Burnley, Vic.

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COPPER DEFICIENT SOILS IN WESTERN AUSTRALIA.

During the last four or five years it has been established by workers in plant and animal nutrition in Western Australia, that a variety of soil types in many agricultural districts are deficient in available copper. Animal and plant disorders, associated with agriculture confined to these soil types, have been cured by administration of copper compounds. Dr. H. W. Bennetts and his co-workers[1, 2, 3, 4, 5, 6] have proved that enzootic ataxia of sheep in the Gingin and Dandaragan districts, north of Perth, and "falling disease" of cattle in certain of the southern dairy districts, are related to copper deficiency. With respect to plants, the writer and co-workers[7, 12, 13, 14] have discovered many instances of copper deficiency in wheat, oats, barley, maize, Sudan grass, Wimmera rye grass, subterranean clover, garden peas, runner beans, cucumbers, pumpkins, onions, swedes, grape vines and certain fruit trees.

Fundamentally, it appears that copper deficiency in soils may be traced to the geological formations constituting the parent material. The soil minerals are formed directly or indirectly from degradation of rocks, and if the rocks are poor in minerals containing essential micro-elements, soil deficiencies with respect to these elements may result. Such deficiencies occur especially where the material has not been transported and mixed to any great extent. It has been shown by Dr. Dorothy Carroll (private communication) that the heavy mineral fraction of certain examples of copper deficient soils in Western Australia is very small in comparison with that from soils from sound areas. R. Grenfell Thomas[15] has pointed out that organic limestones and lime sands of marine origin which have been submerged for geologically short periods may be the foundation of deficient soils.

The pedogenic history will also be important. Where geological conditions are uniform, deficiencies are most likely to occur on very old, or senile, soils, and on highly immature soils where the minerals have suffered little decomposition. Very sandy and very gravelly soils and soils formed on certain marine limestones most commonly show micro-element deficiencies in Western Australia.

As yet, it has not been possible to relate copper deficiency positively to any easily observable soil characters. However, in certain established instances, deficient soils exhibit a peculiar looseness and softness not characteristic of types, otherwise similar in texture and general appearance, which carry apparently normal crops. While certain vegetation associations are frequently characteristic of copper deficient soils, it has not yet been possible to establish consistent plant indicators which may be valuable for the detection of copper deficient areas prior to development.

Soils Affected.

The main soil groups on which copper deficiency has been established in Western Australia may be summarised briefly as follows:

1. Soils of Cretaceous Areas at Gingin and Dandaragan.

   These have been described in detail by Hosking and Greaves.[8] Briefly, they range from grey to red sands and sandy loams, formed on highly weathered green sand, to black (rendzina) clays on chalk outcrops. All types appear to be more or less copper deficient. On one property in the Dandaragan district the most acutely copper deficient soils are associated with diatomaceous deposits in depressions in the greensand formations.

   These districts carry a forest chiefly of marri (*Eucalyptus calophylla*), *Banksia* spp., blackboys (*Xanthorrhœa* spp.) and scrub, and receive an annual average rainfall of about 30 inches.

2. Soils of the South-West Coastal Districts.

   A range of soil types, particularly in certain districts of the south-west coastal agricultural areas, appears to be more or less copper deficient.

One of the main agricultural manifestations of some nutritional disorder of pasture soils is deterioration of subterranean clover (*Trifolium subterraneum*) swards and the establishment in its place of inferior species such as drooping flowered clover (*T. cernuum*), flat weeds (*Hypochoeris* spp.), brome grasses, silver grasses (*Festuca* spp.), etc. Other cases of copper deficient soils involve progressive deterioration of vegetable crops and failure of certain cereals.

The particular soil types associated with these disorders include

(*a*) Immature, sandy and gravelly soils, grey to grey-brown in colour, formed on highly acidic gneissic rocks. The forest cover consists chiefly of jarrah (*Eucalyptus marginata*) and marri, and the annual average rainfall is from 35 to 40 inches.

(*b*) Brown sandy soils of karri (*Eucalyptus diversicolor*) hills along the south coast, where similar rocks occur and the average annual rainfall is about 50 inches.

(*c*) Wet heath soils. These soils are composed largely of quartz sand with a surface layer of raw humus or peaty material. Restricted drainage is responsible for the main soil characters.

(*d*) Sandy swamp soils of the south coast.

(*e*) Grey marls of coastal swamps in the vicinity of Albany and Denmark. Manganese, in addition to copper, is required on these soils for certain crops such as potatoes and peas.

3. Coastal Sand Hill Soils.

Grey calcareous sands which occur very generally along the coast have long been known to be deficient for stock. The so-called " coasty " disease of stock depastured on these sand hills is the result of a cobalt-copper deficiency. Recent experiments in Western Australia indicate that certain types of these coastal calcareous soils are deficient in copper and zinc for cereal crops. These soils resemble those of Robe, South Australia, where early investigations of copper deficiency were carried out.[9, 10, 11]

4. Sandy and Gravelly Soils of the Wheat Belt.

While much of the light lands of the Western Australian wheat belt shows no evidence of copper deficiency, types locally known as wodjil soils have long been recognised as unsatisfactory for cereal crops, particularly wheat, which commonly fails to form grain in the heads on these types. Many instances of response to copper-containing fertilisers when used on these soils have been reported in the last two years, and it appears that copper deficiency has been responsible for many of these crop failures in the past.

These soils carry wodjil, an inclusive local term for scrub, the chief constituents of which are species of *Acacia, Grevillea, Hakea, Casuarina, Dampiera, Baeckea,* and other genera. They lie chiefly in the 12 to 17-inch rainfall belt.

Copper in Plants.

The manifestations of copper deficiency in plants have been described by many authors. A few of the more obvious symptoms are exanthema of certain fruit trees ; leaf tipping, lack of stem elongation and empty heads of cereals ; stunting of vines and failure of fruit in tomatoes ; chlorosis of pumpkins and beans ; empty pods (wind bags) of garden peas ; pointed and crescent-shaped tubers in potatoes ; pale green thin leaves of subterranean clover.

The copper content of some plants gives an indication of the copper status of soils. On highly deficient soils, subterranean clover leaves at flowering and wheat or

oat leaves in the first six or eight weeks of growth, commonly contain less than three parts per million of copper on an oven-dry basis. Under moderate copper deficiency these plants may contain up to five or six parts per million of copper. Where copper supplies are adequate, these plant materials commonly contain from seven to twelve parts per million. Grape vine, pear and apple leaves usually contain less than four parts per million under copper deficiency conditions and substantially more where the soil copper status is normal. Unfortunately, the copper content of many other species of plants does not appear to be a satisfactory index of the copper status of soils.

Treatment.

Copper deficiency may be corrected at small expense by the use of fertilisers containing small amounts of copper. Bluestone, oxidised copper ore, and sulphide residues from sulphuric acid manufacture have proved very effective in Western Australia.

By contrast with South Australian experience, very small amounts of copper are effective under Western Australian conditions investigated. Generally maximum responses are obtained from applications of 5 to 10 lb. of bluestone per acre, or its equivalent in suitable copper substitutes. On very sandy and gravelly types, maximum responses have been obtained from 2½ lb. of bluestone per acre. On these soil types, considerably reduced yields have resulted in some instances where 10 lb. and even 5 lb. of bluestone per acre have been applied. Although the bluestone is applied mixed with superphosphate, very small quantities may be poisonous on soils which are very low in organic or inorganic colloids. Where the rainfall is higher and on soils containing appreciable amounts of clay or humus, more than 10 lb. of bluestone per acre may be used without obvious harmful effects, but no benefit in yield has yet been observed.

The residual value of such small applications of copper is substantial and the succeeding crop may show small response, even no response, to additional treatment with copper.

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MOLYBDENUM DEFICIENCY ON A SOUTH AUSTRALIAN IRONSTONE SOIL.

Ironstone soils in the Meadows district of South Australia have for many years failed to produce satisfactory yields of pasture, even where liberal quantities of superphosphate have been applied. It has been observed that improvement invariably results from the burning of timber on the ground, and this effect has been produced in recent years by the application of wood ashes to the pasture (see Fig. 1). Over the last few seasons experiments have been in progress on the property of Mr. Norman Brookman, "Burbrook", Meadows, with the object of determining the factors concerned in the response to wood ashes.

Figure 1.
Response of subterranean clover to wood ashes on an ironstone soil at Meadows, S.A.
(Photo.—*A. D. Cocks.*)

Lime and other alkaline earths have been shown to improve the yield of pasture, but the effect has been greatly inferior to that of wood ashes. During the course of the work, copper, manganese, zinc, boron, iron and potash have been applied singly, and in various combinations, but have failed to produce any significant effect.

Molybdenum was tested in the field for the first time in 1941. Ammonium molybdate at the rate of 1 lb. per acre was added to a mixture of the above six elements, and applied to a seeded pasture of subterranean clover, perennial rye-grass and *Phalaris tuberosa*, in replicated plots of 1/200th acre. A comparison of the yields of subterranean clover obtained from plots treated as indicated in 1939 and 1941 is given in Table 1.

TABLE 1.
Effect of Molybdenum on Yield of Subterranean Clover.

Treatment, 1939 ..	B	B	Mn	Fe	Zn	B Mn Fe Zn
,, 1941 ..	K Cu	Cu	K Cu Mn B Mo Zn Fe	K	—	K Cu
Yield, 1941. Cwt. dry matter per acre	2·17	2·74	26·63*	2·74	1·93	2·52

S.E. (means of 2 plots), 2·29 cwt. * $P<1\%$.

The response in growth and composition of the seeded pasture to the minor elements including molybdenum is shown in Figures 2 and 3.

A spectrographic analysis carried out by Mr. A. C. Oertel of the Waite Institute had previously shown that the molybdenum content of both lucerne and *Phalaris*

Figure 2.
Seeded pasture receiving superphosphate only, Meadows, S.A.

Figure 3.
Seeded pasture receiving minor elements, including molybdenum, Meadows, S.A.
(Photos.—*A. D. Cocks.*)

tuberosa was higher in material from a burnt area than from adjoining unburnt ground.

In 1941 both the water-soluble and water-insoluble portions of wood ash were effective in increasing the yield of subterranean clover. A spectrographic analysis of the soluble and insoluble portions indicated that comparable amounts of molybdenum were present in each fraction.

Following the evidence of the response in the field to a mixture of elements including molybdenum, an experiment was carried out on the same soil in pots to determine the effect on lucerne of molybdenum, copper and potash, in a $2\times2\times2$ factorial arrangement; the eight combinations were applied with and without a mixture containing iron, boron, manganese and zinc, resulting in sixteen final treatments. Molybdenum applied as sodium molybdate at the rate of 2 lb. per acre, increased the yield of lucerne from 1·60 gm. to 3·13 gm. dry matter per pot ($S.E.=0\cdot195$ gm.; $P<1\%$). In addition to this marked increase in growth, the leaves of plants receiving molybdenum were a healthy dark green colour, in contrast to the yellowish to pale green colour of plants not receiving molybdenum.

The response of herbage plants to molybdenum has recently been confirmed in a second series of pot cultures in which 1 lb. per acre of sodium molybdate has produced marked increases in the development of subterranean clover.

Field experiments are now in progress to determine the relation between the yield of seeded pasture and the application of various quantities of molybdenum. The possible additional role of other mineral elements is also being investigated.

There is evidence to suggest that considerably less molybdenum than is provided by 1 lb. per acre of sodium molybdate is likely to prove effective.

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THE USE OF A LIVESTOCK VACCINATING SYRINGE FOR LARGE-SCALE PLANT INOCULATIONS.

As pointed out by Ivanoff (Phytopath. 24: 74-76, 1934), methods which are satisfactory for inoculating plants on a small scale may be impracticable when large numbers of uniform inoculations must be made rapidly under field conditions. Ivanoff devised an inoculator which he used successfully on a large scale for inoculating sweet corn stalks with the causal organism of bacterial wilt.

During the past three years, the writer has inoculated the stalks, ears, and growing apices of numerous maize plants with aqueous suspensions of fungal spores and hyphæ and bacteria. An inoculator made according to Ivanoff's design was satisfactory when used on young, tender maize stalks, but not when used on older stalks, of which the pith had begun to lose its succulence. Under the latter con-

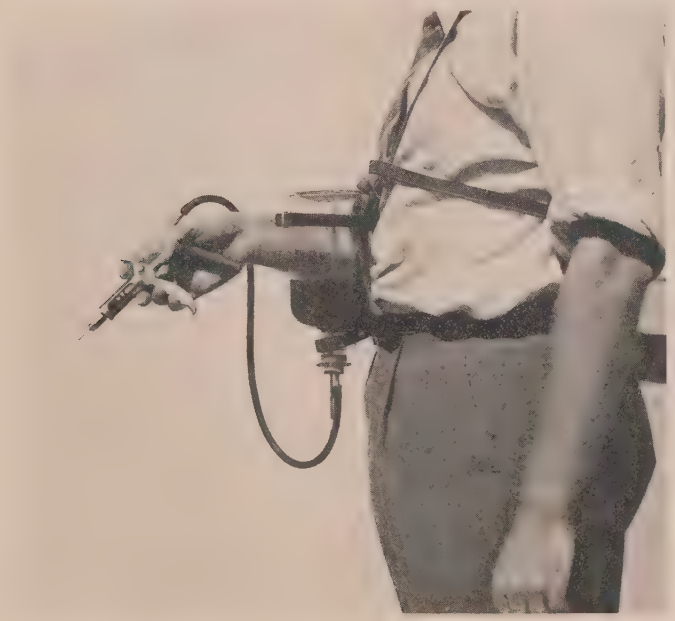

Figure 1.
The " Drench-or-Vax " livestock drenching and vaccinating syringe, ready for use as a plant inoculator.

ditions, small fragments of parenchyma tended to become detached by the insertion of the hypodermic needle, and to block its aperture. They could not be ejected by the pressure of the liquid inoculum, which drips through the needle under the influence of gravity only.

This difficulty was largely overcome, and other advantages were obtained, by using an instrument known as the "Drench-or-Vax" (made by Sayers, Allport & Co., 53 Macquarie Street, Sydney, N.S.W.), which is designed for drenching and administering hypodermic injections to livestock. One of these instruments was used for thousands of inoculations during the past three seasons. Trouble was encountered only when excessive pressure was exerted on the needle or piston, or when solid particles in the inoculum lodged in the valves, causing them to leak. The latter difficulty was prevented by straining the inoculum through cheesecloth.

Figure 1 shows the apparatus ready for use. The piston which forces the inoculum through the needle is operated by compressing the two grips between the fingers and the base of the thumb. On releasing this pressure, a coil spring returns the piston, and a further dose of inoculum is automatically sucked from the reservoir into the glass barrel, the direction of flow being controlled by rubber composition valves. The needle found most useful for stalk inoculations was a 16-gauge stainless steel hypodermic, one inch long. The end of the needle was sealed and a side opening made as described by Ivanoff (*loc. cit.*). The instrument can be adjusted to deliver reasonably uniform doses ranging from about 0·1 ml. to 5 ml., and can be sterilized without being dismantled by pumping 2 per cent. formalin through it, followed by sterile water.

The advantages of this instrument for the types of plant inoculation to which it is adapted include the following:

(1) Any plant material blocking the needle can usually be forced out by operating the piston.

(2) By fitting an appropriate nozzle, the instrument can be used to discharge a jet or a fine spray of inoculum on small unwounded areas, such as the tips of maize ears.

(3) As in the Ivanoff inoculator, the inoculum is brought into contact with the broken ends of the vessels in a stem at the instant they are severed, and is therefore drawn into the vessels by the negative pressure in them. This is assisted by the positive pressure exerted by the piston of the "Drench-or-Vax". Dilute India ink injected into maize stalks with the latter instrument penetrated the vessels to a maximum distance of about 25 cm. from the wound within 5 seconds of injection.

Tissues too hard to be penetrated by the needle without damaging it, can be inoculated by first piercing them with a sharpened steel icepick or similar instrument, and introducing the needle immediately afterwards. The inoculator is most useful when large numbers of puncture inoculations of thick, succulent tissues have to be done quickly and uniformly, using the same inoculum throughout, as in testing large populations of breeding material for disease resistance. Maize stalks or ears can easily be inoculated at the rate of 30 per minute. A simpler instrument is preferable when small numbers of inoculations have to be made, with frequent changes of inoculum, involving repeated sterilization of the inoculator.

Since the above note was submitted for publication, a description of the use of a similar (but not identical) instrument for injecting liquid fumigants into bags of grain, etc., has been published (Swan, D. C., and Stephen, V.A., This Journal, 8: 26, 1942).

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The Australian Institute of Agricultural Science

MEETING OF COUNCIL.

At the meeting of Council held on 9th February at the Department of Agriculture, Melbourne, Mr. E. T. Morgan was admitted to membership, and notice was received of transfer of membership to the Victorian Branch of Mr. J. S. Hosking from Western Australia and of Miss Lorna Byrne, now with the Australian Women's Army Service, from New South Wales. It was affirmed that the subscription concessions to members on active service will apply in future to members serving with the Australian Military Forces.

The financial statement for 1941 indicated a surplus of receipts over expenditure of £71 13*s.* 6*d.* On the recommendation of the Honorary General Treasurer, Mr. R. L. Twentyman, the Council approved of the payment of the usual Branch grant of 5*s.* 6*d.* per member.

MEETINGS OF BRANCHES.

Australian Capital Territory Branch.

The seventh annual general meeting and dinner were held on 25th March. The following office-bearers were elected for 1942: President, Dr. J. G. Davies; Secretary-Treasurer, Mr. R. M. Moore; Delegate, Dr. J. R. A. McMillan; Sub-Editor of Journal, Dr. W. V. Ludbrook; Other members of Committee, Dr. B. T. Dickson, Mr. F. J. Gay, Mr. K. Loftus Hills; Auditors, Mr. E. Mackinnon, Mr. S. G. Gray.

Subsequent to this meeting, Dr. Ludbrook tendered his resignation as local sub-editor of the Journal. Mr. Gay was appointed in his stead and Mr. Mackinnon was appointed to the vacancy on the Committee.

New South Wales Branch.

Members, together with a number of veterinarians and economists, gathered at an informal dinner which was held at the Union, University of Sydney, on 24th April. The guest, Mr. Dawson, Agricultural Attaché in the Orient of the United States Department of Agriculture, briefly traced the growth of crop forecasting and of recording agricultural statistics in U.S.A. The subsequent discussion in which many participated centred for the most part around the responses during the past ten to fifteen years to economic and agricultural policies.

A general meeting of the Branch was held on 8th May, with an attendance of 25 members and six visitors. The meeting paid respect to the memory of the late Dr. Darnell Smith.

The Branch was represented by Dr. S. L. Macindoe and Dr. E. T. Edwards at the meeting of the Australian Association of Scientific Workers held on 21st and 22nd February, 1941. Motions expressing the need for a national agricultural executive and a Director-General of Food Supply were sent to the Prime Minister. The resolutions had subsequently been discussed at several meetings representing all primary producers organisations.

Upon the result of a postal ballot it was decided to hold ordinary general meetings at the discretion of the Committee of Management, instead of regularly five times a year.

Reports on three Branch projects were received. On that dealing with the utilisation of agricultural scientists in the war effort, Mr. A. W. S. Moodie explained the suggestions put before the Ministers for Air and for the Army and the replies were read. The Committee was empowered to take further action, the need for concrete suggestions in communications to Ministers being stressed.

The Committee appointed to study pasture growth and composition requested that its work be held in abeyance for the duration of the war.

The report of the committee to study reorganisation of Australian agriculture to meet war-time conditions formed the main business of the meeting. The substance of the report was presented by Dr. Bowman. It was a majority report subscribed to Dr. S. L. Macindoe (convener), Dr. F. T. Bowman and Mr. L. C. Holmes. Mr. H. Bartlett was also elected to the committee, but was unable to subscribe to the views in which restrictions of production of some commodities were indicated.

During the discussion, the recently appointed Food Council was considered inadequate to carry out the functions of a national agricultural executive. It was also stated that the Department of Commerce had earlier invited State Departments of Agriculture to appoint liaison officers

to its staff. Opinion was expressed that while this may have improved the present unorganised condition of Australian agriculture, it was considered the appointment of a Director-General of Agriculture would be a better way to coordinate the activities of the several State and Commonwealth departments.

The following motion was passed: "That the Australian Agricultural Council is not so constituted as to enable Australian agriculture to cope with war-time conditions. Further, there is urgent need for coordination, or overall planning of the Australian agricultural industries and consequent direction of efforts to meet war-time requirements, including maintenance of productive capacity. These would require an adequately constituted national agricultural executive. Such national agricultural executive should implement its decisions through the respective State agricultural executives and local (district) planning committees."

It was further resolved that the report prepared by the committee on reorganisation of Australian agriculture to meet war conditions be accepted, with the exclusion of a section dealing with a plan for the wheat industry.

The amended report appears in this issue of the Journal under the title "Organising Agriculture for War".

Queensland Branch.

The seventh annual general meeting was held at the University of Queensland on 31st March. The following officers were elected for 1942: President, Dr. D. A. Herbert; Vice-Presidents, Messrs. J. H. Smith and W. A. Summerville; Sub-Editor, Mr. W. W. Bryan; Secretary-Treasurer, Mr. C. W. Winders; Additional members of Committee: Messrs. A. R. Brimblecombe, A. F. Bell and C. R. von Stieglitz; Auditor, Mr. E. W. Bick.

The retiring President, Mr. J. H. Smith, delivered an address on "Some Recent Advances in Economic Entomology", a summary of which is reported under Current Notes and News in this Journal.

South Australian Branch.

The South Australian Branch held the annual general meeting on 26th March, 1942. The following office-bearers were elected: President, Mr. D. B. Adam; Vice-President, Mr. J. K. Taylor; Sub-Editor, Mr. H. G. Andrewartha; Treasurer, Mr. C. S. Piper; Secretary, Mr. T. T. Colquhoun; Members of Committee: Mr. J. C. Fornachon, Dr. I. F. Phipps and Mr. A. G. Strickland.

An address was given on "Some Aspects of the Apple and Pear Acquisition Scheme", by Mr. A. G. Strickland, who is a member of the Apple and Pear Board. The address provoked a lively discussion. Many members thought that the interests of the consumer had not been adequately served by the Board.

Members attended an address on "Some Aspects of Vitamin Nutrition" which was given by Mr. A. W. Peirce to the Agricultural Sciences Club of the Waite Institute on 24th April. An interesting review of the subject was enlivened by reference to research now going on at the laboratories of the Council for Scientific and Industrial Research, Division of Animal Nutrition. The problem of providing an adequate level of vitamin C in army diets had been tackled with considerable success. Mr. Peirce exhibited specimens of dried cabbage and sprouted leguminous seeds, including blue boiler pea and two Chinese beans (mung bean and red gram bean), all of which provide good sources of vitamin C in a palatable form. Improvements in canning methods had increased the vitamin C content of canned food.

Victorian Branch.

The seventh annual meeting of the Victorian Branch was held on 1st May. The annual report showed that the Branch membership at the end of December, 1941, was 117 corporate members and one student member. One member resigned. There were three outward and two inward transfers. Sixteen members were on active service. Reference was made in the report to the splendid services rendered by Dr. H. J. Hynes as Editor of the Journal. Branch finances were satisfactory. The average attendance at 11 general meetings (seven of which were arranged by the Melbourne University Agricultural Society) was 50.

Office-bearers elected for the ensuing year were: President, Mr. H. A. Mullett; Vice-Presidents, Mr. J. A. Aird (*ex-officio*), Mr. G. W. Leeper (Past President) and Prof. S. M. Wadham; Secretary, Mr. W. D. Andrew; Treasurer, Mr. C. E. Cole; Sub-Editor, Mr. F. S. Crawford; Members of Committee, Messrs. R. A. Boyle, L. C. Bartels, T. S. Bellair and Dr. H. C. Forster; Auditor, O. H. Gepp. Mr. Leeper's presidential address was entitled "What Use is Soil Science?"

Members also attended the annual meeting of the Melbourne University Agricultural Society on 17th April, when Mr. R. L. Twentyman spoke on " The Melbourne University Agricultural Society—Our Twentieth Year ". Mr. Twentyman described the circumstances under which the society was founded and then gave a list of agricultural topics which had temporarily aroused special interest during its brief existence. Their wide range indicated the necessity for agricultural workers being familiar with many branches of pure science if they were to maintain a rational outlook on new developments relating to agriculture. The difficulty of the agricultural worker to keep abreast of recent developments in pure science was greatly increased by the frequent use in scientific literature of words and expressions peculiar to each particular branch of science. Mr. Twentyman suggested that, when writing on agricultural subjects, only words or terms of common usage should be used, or where special terms must be used they should be such that their approximate meaning could be deduced from the context.

Attention was drawn to the prosperous state of agriculture in the years when the society was formed. Demand exceeded supply and all agricultural products commanded high prices. Aided by many scientific discoveries, farms were regarded as factories and farming was looked on as a means of " making money ". Declining prices were countered by increasing production, thus lowering costs. This disregard for the law of supply and demand, continued Mr. Twentyman, has brought about conditions whereby economic considerations now attract greater interest than do means of increasing production. The opinion was expressed that so long as farms were organised as specialised units not capable of manoeuvring in response to the requirements of supply and demand, such farms would be at the mercy of every economic storm that blew.

Mr. J. L. Provan was elected President for 1942, Dr. H. C. Forster and Mr. W. J. B. McDonald, Vice-Presidents, and Mr. K. Northcote, Secretary.

On 15th May Mr. H. G. A. Osborne spoke on " Food Canning " at a meeting of the Melbourne University Agricultural Society. He reviewed methods of food preservation, drying, smoking and pickling, fermentation and the latest modern development, refrigeration. The evolution of the present tin-plate container, with its internal cover of lacquer to prevent attack by food acids and sulphur, the necessity for perfect seams and closures, and the canning process which, if done satisfactorily will ensure that the products will keep indefinitely, were discussed. Modern processes completely destroy food poisoning organisms such as *Botulinus* and *Salmonella* groups, stated Mr. Osborne, and canned foods contain almost the same vitamin C content as the fresh product, while vitamins A, D and B_1 are not affected to any great extent. The present exceptional demand for canned foods and the shortage of tin-plate are the immediate problems of the Australian canning industry.

Western Australian Branch.

The annual general meeting of the Western Australian Branch was held on the 24th April, and was devoted entirely to the transaction of formal business.

The annual report showed that membership stood at 56 corporate members ; of these four are with the A.I.F. and three with other branches of the fighting forces. The financial statement showed a satisfactory balance at bank. The following office-bearers were elected for the ensuing year : President, Dr. G. A. Currie ; Vice-President, Mr. W. P. Cass-Smith ; Past President, Mr. F. L. Shier ; Hon. Secretary, Mr. R. P. Roberts ; Hon. Treasurer, Mr. G. R. W. Meadly ; Committee Members, Messrs. C. F. H. Jenkins, H. L. Harvey, M. Cullity, R. Moir ; Sub-Editor, Mr. G. H. Burvill ; Auditors, Drs. L. W. Samuel and E. J. Underwood.

In taking over the presidential chair, Dr. Currie briefly referred to the future activities of the Western Australian Branch in view of war-time conditions. He urged that a few very good meetings, devoted principally to war-time agricultural problems, should be held. He was keen to see due attention given also to post-war reconstruction problems, for he held the belief that we might lose the peace unless some definite post-war reconstruction plans were now formulated. Dr. Currie pointed out that with increased food supplies required within Australia, there must be opportunities for making full use of the specialist agricultural knowledge and experience possessed by Institute members.

Current Notes and News

Recent Advances in Economic Entomology.

Recent advances in economic entomology formed the subject of the presidential address delivered by Mr. J. H. Smith at the annual meeting of the Queensland branch of the Institute. The principal phases of the subject discussed were biological control, insecticides and plant resistance to insect attacks.

Biological control has found a place in the entomological programme of most countries in which economic entomology has had serious attention. It seems remarkable that the success actually achieved was obtained, for a generation ago theoretical ideas regarded the *modus operandi* of parasites was much simpler than is now known to be the case. Entomologists are today much less sanguine than their forebears as to the wisdom of initiating biological control work.

This is due to a vivid appreciation of the failures in biological control work which are on record in most countries, the knowledge that the host-parasite relations of even important pests have seldom been studied in sufficient detail before introducing parasitic insects, and finally, the extreme difficulty of identifying parasites, particularly in countries such as Australia. In short, entomologists cannot help but feel that the basic information required for the scientific exploitation of the biological control method is seldom available. In these circumstances, it is not perhaps surprising that the theory and practice of biological control have received a great deal of attention in recent literature. These discussions are, in part, an attempt to clarify first principles, but they do much more than that. They are symptomatic of a sharp cleavage between the lay conception of biological control as a simple, cheap and permanent method of eliminating a pest problem and the entomologist's view of the problem as a highly speculative operation, the risks of which can only be reduced to manageable proportions by detailed studies of the insects concerned over a period of years and often at considerable expense.

It seems very probable, therefore, that, even in Queensland where lay enthusiasm for biological control following the spectacular eradication of prickly pear by *Cactoblastis*, has always been high, no important developments are likely to take place in the immediate future. Nevertheless, there can be little doubt that biological control will some day come into its own, particularly for the limitation of pest populations in forests and field crops.

Insecticides. One of the main developments of recent years has been the rapid increase in the use of plant products, such as derris and pyrethrum. Both have been available for very many years. Now they can be assayed with some sort of accuracy, though it must be admitted that the chemical assay and the insecticidal properties, as determined by experiment in the field, do not always tally. Two of the most recent developments in pest control practice concern combinations of these products with oils that have long been used for pest control.

Oil sprays are, of course, used widely for the control of citrus pests, but the concentration is often very close to phytocidal limits when good control of the pest is to be obtained. By incorporating derris in the oil, it has been found possible to maintain the kill—and sometimes to increase it—with a much lower concentration of oil than would otherwise be used. To incorporate the derris in the oil is by no means an easy problem, but " solubilizers " have been discovered which overcome this difficulty. This new development suggests a way out of the Queensland dilemma in citrus areas, where control of both bronzy orange bug and scale pest is necessary. Derris gives a reasonable degree of control of the bug and various oil sprays give reasonable control of the scale insects. A combined spray, properly applied and timed, might well solve the problem without the necessity of adding a further spray to the already overloaded schedule practised by the better type of grower.

Pyrethrum-oil sprays are of more interest in connection with the control of some stored product pests. A few years ago, Potter in Great Britain found that the film left on any surface, after the application of a spray containing an ether extract of pyrethrum in an oil of the medicinal paraffin type, continued to be lethal to larvæ or moths, which come in contact with it, for a period of some weeks. The spray without any dilution in water is applied through a spray gun motivated by air pressure. The spray is non-tainting and can thus be used in and on products which very readily take up odours. For this reason it holds promise of being useful for the control of one of the stored products which has for many years been subject to pests, namely peanuts in silos. Mr. D. O. Atherton initiated work on the subject at Kingaroy a year or so ago and so far there is no reason to suppose that the spray is any less effective than it proved to be in England.

Storage pests are a source of considerable loss in tropical and sub-tropical countries, and there can be little doubt that sprays of the medicinal paraffin-pyrethrum type will in the future be generally applied in all the larger warehouses and storage depôts.

Plant Resistance to Insect Attack. The selectivity shown by some insects in the field is well known. In some instances, the adult seems to show a remarkable prevision by laying its eggs where the chances of development of its progeny are greatest. For example, the corn ear worm tends to lay its eggs on cotton plants which are somewhat rank in habit. A recent study of the phenomenon in cotton by Barbour and Parsons in South Africa has brought to light the fact that

the protein content of the fruiting forms with this type of growth is much higher than the plants which are less subject to attack, and this agrees with the fact that the rate of development of the larvæ, and their survival, depends largely on the nutritive balance in the parts of the plant eaten. It does seem probable, therefore, that with this and some other pests of field crops it may be feasible to so arrange agronomic practices that the type of plant grown, though commercially adequate, will be more or less unattractive to important pests. This is the key to the current cotton-growing project at Ayr, a centre where climatic and other conditions are extremely favourable for *Heliothis*. Resistance to insect attacks of this kind may conveniently be termed physiological.

A second type of plant resistance is exemplified, in part, by the cotton jassid. Some varieties of cotton are almost immune to attack. There seems to be no doubt that the insect can feed on and grow on these resistant varieties : their resistance is due to the fact that eggs are simply not laid, or not laid in any great quantity, on the plants. The evidence suggests that the inability of the insect to lay its eggs on the plant is linked in some way with hairiness. This type of resistance can be termed morphological.

It will be apparent from the above that entomologists are being compelled willy-nilly to follow the technical path which has been such a conspicuous feature of disease control investigations during recent years. The prospects are in some respects anything but attractive, for pests have a decided faculty for adapting themselves to new situations. The effort must be made, for, with field crops particularly, the only permanent solution of some problems lies either in the use of plants with morphological or physiological characters which confer resistance, or adopting cultural practices which confer resistance without reducing the commercial value of the crop grown.

Endeavour—a New Scientific Quarterly.

The first number of a new journal publishing articles of general scientific interest appeared in January this year, under the title of *Endeavour*. The journal takes its name from the barque *Endeavour*, which will always be associated with the name of the great navigator Captain James Cook, and, from the results of its voyages, with the idea of scientific discovery.

The variety of material in the first issue illustrates the wide fields of science from which it is intended to draw contributions. The subjects include astronomy, genetics, industrial chemistry, soil conservation, biological oceanography, physics ; there are several biographical studies, a section on book reviews and another giving brief notes on the contributors themselves. Portraits and illustrations are a feature of the first issue, which occupies 47 large quarto pages. With such a wide range of subject for review, the contributions are necessarily short and of a type suitable to the general scientific reader.

The quarterly is published by Imperial Chemical Industries, London, S.W.1, and is priced at five shillings per number.

Abstracts of Animal Production and Veterinary Science.

The publication of a new section of *Biological Abstracts*, known as Section F, is designed to meet the needs of men engaged in the animal industries. It will contain all of the abstracts in the present edition of this well known publication that have to do with the breeding, nutrition, metabolism, husbandry, reproductive and other physiology, anatomy, pathology and parasitology, arthropod pests of livestock, poultry, and semi-domesticated animals and birds, including pet stock.

It appears from the first issue, published in January this year, that research papers in these fields are much more widely scattered throughout the biological literature than is generally assumed. The 514 abstracts in this issue were drawn from 135 journals. Since *Biological Abstracts* now abstracts the literature in 1,575 periodicals, subscribers to the new section will be assured a very great breadth of selection.

The new section will consist of ten abstract issues per year. The annual subscription rate will be 5 dollars. Subscribers will receive the index to the complete edition of *Biological Abstracts*.

10-Year Index to Horticultural Abstracts.

At the first Imperial Horticultural Conference, held in London in August, 1930, the following resolution was adopted: "That a commentary on current horticultural literature is desirable and should take the form of summaries of sufficient length to indicate the contents and scope of the papers concerned."

Horticultural Abstracts, which gives the gist of the more important horticultural papers of the world, was the result.

Now, after 10 years, the work has been rounded off by the provision of a single, comprehensive, subject and author index covering the whole period. The inquisitive horticulturist, using both index and abstracts in conjunction, will here find an efficient summary of information on all modern horticultural problems, together with exact references to original

Correspondence

INTERNATIONAL COMPARISONS OF AGRICULTURAL PRODUCTIVITY.

The Editor,
Journal A.I.A.S.

Sir,

I was pleased to note that my article in the September number of the Journal resulted in comment from three sources in the December number, and a letter in the March number.

I agree with Mr. Paling, my first critic, that the agricultural economist must have a knowledge of the foundations of the science of economics as outlined by him. I consider, however, a knowledge of the fundamentals of agricultural science—organic and inorganic chemistry, plant and animal physiology, genetics, and soil physics and chemistry—equally essential. I cannot agree that " an economist with an agricultural bias ", to quote the Australian Commonwealth Territory Branch memorandum, is capable of undertaking research into matters pertaining to agricultural science. In fact, it is surprising that a body of such distinguished scientists as the Canberra Branch should consider that a person answering the above description is qualified to undertake research in agriculture, a science the fundamentals of which such a person would know practically nothing. In my opinion, a composite five (or perhaps four) years course could be designed for training agricultural economists, but failing it, I consider that the agricultural graduate needs two years' study in economics and related subjects, and the economics (or commerce) graduate three years' study in the fundamentals of agricultural science before justifying the title of agricultural economist.

With regard to Mr. Clark's comments, I agree with him that there is a difference between real and money income. I also quite understand that what Mr. Clark attempted to do in chapter 7 of *The Conditions of Economic Progress* was to compare average real incomes, produced per rural worker in the various countries, and to use them as a comparison of productivities. My point was that I considered that actual amounts received in local currency, compared by rates of exchange, gave a closer approximation to the figures desired than the method used. My main reasons were the high percentage of agricultural products used on the home market and the relation of rates of exchange to comparative values.

If every country could confine itself to those forms of production for which it was most suited, then some system of valuation based on a world price would give a comparison of productivities, but, apart from tariffs, perishability and bulk in relation to value make it necessary for a large proportion of the food requirements of any country to be produced within a reasonable distance of the market, and, therefore, agriculturalists produce not what is most suited to the district at a world price, but what gives the best return at the local price.

I quite agree that a more accurate set of figures than those based on local values could be computed, but I still adhere to my previous opinion that materials consumed entirely on the local market should be considered at the local value. Regarding materials grown partly for export and subject to marketing control systems and tariffs, I am not so certain. Mr. Judd refers to the prices of New Zealand and Australian butter exported to Great Britain. These, however, cannot be considered as final, as both countries enjoy a measure of preference in Great Britain. Mr. Judd also quotes me as showing that " local consumption of dairy products forms a very small part of the total production of either country (New Zealand or Australia) ". This I did not do, as anyone, who is familiar with Australian production statistics, knows that between 1925 and 1934 Australia consumed practically half the butter it produced as well as the market milk, all of which was used locally.

Mr. Clark has pointed out that Professor Pigou has suggested that two countries might be compared by valuing the goods of each at the prices received in both countries and taking the geometric mean of the two ratios. Adopting values quoted by me for milk, lamb and mutton, Mr. Clark has prepared a table on this basis for Australia and U.S.A., and points out that the relationship is 1 to 8·4 as compared with 1 to 7·73 on his original figures, a difference of 8 per cent. This difference he considers of no great importance ; it would, however, be equivalent to a reduction in the income per producer from £381 to £350.

In the table, however, Mr. Clark assumed that prices of all other Australian and American products will balance out and that total values at Australian and American prices will be equal. I cannot agree that this is so. For instance, I showed in my previous paper that the Australian prices for wheat and cattle, major lines of production in both countries, were respectively 10 per cent. and 20 per cent. lower than the American. These may be counter balanced to some extent by some products, such as maize, dried fruit and fresh fruit for canning, for which Australian prices are higher than those in U.S.A. The effect of these would, however, be comparatively small. Valuing American wool at American prices would have a similar effect on the ratio, but I am of the opinion, from my general knowledge of the prices of agricultural produce in both countries,

that the value of the balance of the Australian produce (other than the milk, lamb and mutton mentioned above), at Australian prices, would be considerably less than at the American.

Mr. Clark does not consider that allowance for skim milk fed on farms would materially affect the figures. In this I disagree with him. Were all Australian milk sold as whole milk at butter fat prices and not used for animal food, there would probably be a reduction of 15 million to 20 million dollars (3 to 4 per cent.) in the calf, pig and poultry production.

Mr. Clark objects to my description of his " International Units " as " American dollars ". I should like to point out that the table opposite page 244 is headed " Net Agricultural Production valued at International prices $ million per annum ". The quotient obtained by dividing the totals of this " Net Agricultural Production, etc." by the number of males engaged in agriculture is, however, described as " International Units ". These do not, however, answer to the definition on page 39 of an International Unit as " the amount of goods and services which one dollar would purchase in the U.S.A. over the average of the period 1925-34 ". As I pointed out, the prices are also not " International ".

With regard to the comparative real incomes of Australian and New Zealand agriculturalists, my statement was that I did not get the impression that production per head of the New Zealanders was nearly double that of the Australians ; more comparable figures are those now quoted by Mr. Clark of £245 per male person engaged in agriculture in Australia and £309 in New Zealand. I also cannot agree that figures of motor cars per thousand of people in the two countries have anything but a distant connection with the production per primary producer. If they do, how does Mr. Clark explain his figures of 140 cars per 1,000 people in New Zealand with a primary production of 2,444 " International Units " with those of the U.S.A. of 225 cars per 1,000 people and primary production of only 661 " International Units " ? Anyway, the number of motor cars in a country depends on dozens of other factors in addition to the production per primary producer and the effect of a variation of them would be determined only by a thorough statistical analysis.

Mr. Leeper, in disagreeing with my criticism, states " the only way of comparing an Australian dairyman, an American wheatgrower and an English potato grower is, to say, one sack of potatoes equals ' x ' gallons of milk, and one bushel of wheat equals ' y ' gallons ". Assuming he is correct, the question is what are the values of " x " and " y ". Is " x " the number of gallons of milk the Australian grower gets for his sack of potatoes, or the number of gallons the English potato-grower will get for his ?

Mr. Clark insists for various reasons, and Mr. Leeper agrees with him, that the English potato grower and the Australian dairyman should be compared on the basis of exchange between the American potato grower and the American dairyman. In the same way in a comparison between wheat and milk, Mr. Clark compares them on the American basis of five gallons of milk per bushel of wheat, whilst the average Australian would get nearly eight gallons and the New Zealander ten or eleven.

Mr. Leeper disagrees with my statement that it is not sound economics to compare the productivity of the Norwegian dairyman with that of the Australian dairyman on the same price basis, i.e. that of the U.S.A. He states that if I am correct the whole subject of economics collapses, and refers to page 27 of Mr. Clark's book. However, a careful study of pages 27 and 28 will show that the comparison made there between Germany and the U.S.A. is not on the system used by Mr. Clark in chapter 7 (the one under review). On page 27 production is first determined in each country's own currency, i.e. at the prices received for it in that country ; it is then transferred to a uniform currency at the rate of exchange, and finally the figures per head are adjusted by a factor representing the comparative purchasing prices of consumption, goods and services in that country. This is exactly what I advocated in my first article. Mr. Leeper apparently considers that Mr. Clark used this method of chapter 1 in chapter 7. However, as I said above, he did not.

The ratio in real incomes of rural workers between the U.S.A. and Australia can be shown by adopting the method set out by Mr. Clark on pages 27 and 28 and using the figures quoted by him. Thus, he states that the Australian agricultural productivity per rural worker for the year 1934-35 was £245, transferring this to dollars at the 1934-35 rate it equals 980 dollars. In the table on page 51 of the *Conditions of Economic Progress* Mr. Clark states that for the period 1925-34, Australian prices for consumption goods were 126 with U.S.A. as 100 as a base, and, therefore, the actual purchasing power of the production per Australian rural worker was 777 dollars. For the same year Mr. Clark's figure for the U.S.A. rural worker was 661 dollars, which, however, would be subject to some slight increase by valuing U.S.A. wool at U.S.A. prices. Mr. Clark will, I am aware, say that the figure of 777 dollars is not the measure of the real productivity of the farm population of Australia, but, in my opinion, it is the only figure that is of use in comparing productivity, as it is the measure of the production in consumable goods, that is, it is a measure of the production by those things for which it has to be exchanged.

I agree with Mr. Judd that it would have been more accurate to use the average rate of exchange for 1925-34 to the 1934-35 rate for comparing prices. I considered this when writing my first paper, and found that the difference it made was slight.

Space does not permit a full discussion on the matter referred to by Mr. Judd of " optimum " and " living " areas. Shortly, what I meant was that if the " living area " for an industry in a district was, say, 1,500 acres, and for the same industry in another district 500 acres, then there would be approximately a 3 : 1 ratio in the " optimum " areas in the two districts.

Finally, I am sorry I cannot agree with Mr. Leeper in accepting Mr. Clark's ratios for Great Britain, the U.S.A. and Australia. Mr. Leeper mentions the rural slums of the U.S.A., but what about those in Australia ? I have never seen in the results of any farm survey in U.S.A. as low " average labour incomes " as I know prevailed in the dry farming portion of the county of Millewa, Victoria, between 1925-35, the years under discussion.

J. A. Aird.

State Rivers and Water Supply Commission, Victoria,
8th May, 1942.

Book Reviews

THE QUEENSLAND AGRICULTURAL AND PASTORAL HANDBOOK, VOLUME 1, FARM CROPS AND PASTURES, by Officers of the Department of Agriculture and Stock.

(*Pp. V+448 with 197 plates. Government Printer, Brisbane, 1941. Price 5s.*)

This volume is a compilation of practical information for the guidance of farmers, extension workers and students. Following orthodox lines as to arrangement, it deals in a comprehensive manner with the most important farm crops, according special attention to such crops as cotton, tobacco, the sorghums, and the tropical legumes. For this reason, if for no other, this handbook forms an important contribution to our agricultural literature.

To the student of agriculture in southern States, appreciation of the sections devoted to crop-raising is stimulated by the opening chapter, which is devoted to a brief description of the physical geography of Queensland, as well as facts and figures describing the climatic conditions and production in the various statistical divisions. The reader cannot fail to be impressed by the extremely wide range of crops and fruits that can be cultivated successfully in the northern State.

Farm Crops and Pastures is liberally illustrated with excellent modern photographs. In this respect it shows a considerable advance on many other agricultural publications which, by the illustrations, tend to convey the impression that agricultural practice has advanced little during the past half century.

Having in mind the importance of sugar-cane in Queensland, the reader may be disappointed by the apparent failure to present information regarding this crop. Sugar-cane is felt to be of sufficient importance to warrant a special publication, and *The Queensland Cane Growers Handbook* deals with all aspects of this subject.

That Queensland has given considerable attention to the introduction of legumes for green manuring and for stock fodder is evident from the section devoted to these crops. The information on cowpeas, Mauritius and other velvet beans, soy beans, and Crotalarias should prove extremely helpful to farmers.

A considerable section is devoted to pastures and their management, weeds, fodder conservation, and winter fodder crops, which are dealt with in considerable detail. A short chapter dealing with plant breeding and the production of improved strains explains the fundamental facts associated with this work and will prove helpful in explaining to farmers certain causes of crop deterioration and the means that can be adopted, not only to prevent such deterioration but to maintain the purity of varieties and to increase production.

Considerable reticence regarding the yields that can be anticipated from the various farm crops is characteristic of many handbooks on agriculture and in this respect *Farm Crops and Pastures* remains faithful to tradition. It is realised that yields cannot be stated with the same certainty as rates of seeding and recommendations regarding fertilisers, but surely they can be given within reasonable limits. Every advisory worker knows that one of the first questions asked by any farmer about a crop new to him is the likely yield and return per acre. Potential growers of new crops, and agricultural students find such omissions a serious defect in otherwise excellent publications. The Queensland Department of Agriculture is to be congratulated on this excellent publication which is certain to achieve popularity with local farmers.

A. W. S. Moodie.

PASTURES AND PASTURE RESEARCH. Six Lectures delivered at the University of Sydney, 1941, by C. M. Donald, M.Agr.Sc.

(108 *pages, 40 figures and 50 tables. University of Sydney.* 1941. *Gratis.*)

Pastures and Pasture Research is a publication worthy of close attention by all agricultural workers interested in grasslands. It is gradually becoming recognised that grass is Australia's most important crop and that the study and improvement of this crop will increase our national well-being. Mr. Donald deals with various aspects of the most important grassland problems and indicates many directions in which improved technique may be effected.

One of the difficulties of the student of agrostology is the dearth of textbooks dealing with all aspects of grassland research. Mr. Donald's contribution to our literature on this subject does not pretend to present all the information that would be expected in a textbook, nevertheless it deals in considerable detail with the most important aspects of grassland problems.

As indicated by the sub-title, the volume consists of six lectures which bear the following titles : the role of pastures in land use planning, pasture competition and seed mixtures, species and strains of pasture plants, pasture management, the nutritive value of pastures and the technique of pasture experimentation.

Not only is each chapter introduced in its broad and general sense, but as one topic after another is raised in each chapter, examples from Australian studies and experience are given and reference to a wide literature is made. In the text of 100 pages, repeated use is made of many of the 147 references given at the conclusion. Throughout, the work is profusely illustrated by photographs and diagrams and there is an abundance of tabulated data.

A. W. S. Moodie.

Obituary

GEORGE PERCY DARNELL SMITH

The death in retirement of Dr. G. P. Darnell Smith on April 10 closed the interesting career of an historical figure in Australian and world agriculture. In the period 1915 to 1917, Darnell Smith developed the copper carbonate dust treatment for the control of bunt in wheat and inscribed his name on history's scroll. In this treatment he conceived a new method of seed disinfection which was so effective and convenient that it has superseded former procedures of

dipping in chemicals or steeping in hot water. It has been truly said " that this treatment has added a quarter of a bushel to the average yield of the world's wheat ".

Born on October 15, 1868, at Chipping Norton, Oxfordshire, George Percy Darnell Smith received his early education at University College School and University College, London, graduating B.Sc. with honours in Botany and Zoology in 1891. He was appointed research assistant at University College, 1892–93, and from 1893 until 1907 he was lecturer in Chemistry and Biology at the Merchant Venturers' Technical College, Bristol. He was made an F.I.C. in 1900 and in 1912 the University of Bristol admitted him to the honorary degree of B.Sc. The degree of D.Sc. was conferred upon him by the University of Sydney in 1918 for a thesis entitled " The Gametophyte of Psilotum ".

Darnell Smith accepted the position of Assistant Director of Technical Education in New Zealand in 1907 and two years later joined the staff of the Bureau of Microbiology in Sydney. In 1913, on the establishment of the Biological Branch in the New South Wales Department of Agriculture, he was appointed Biologist. There he laid the foundation of the present plant disease and dairy bacteriological service of that Department and developed the " dry copper carbonate " treatment for bunt. Another noteworthy achievement was his work in 1916, in connection with the Gunn anthrax vaccine, in which he succeeded in preparing the vaccine from the disconnected notes left by the late Mr. Gunn. In 1924 Darnell Smith became Director of the Sydney Botanic Gardens and held this position together with that of Biologist until 1927, when he resigned the latter post and assumed an executive position on the Commonwealth Tobacco Investigation Committee. He entered retirement from the position of Director of the Botanic Gardens in 1933.

Darnell Smith was a man of broad outlook and clear vision. He was direct in manner and a realist in his approach to, and in consideration of, a problem. It was his sound common sense that led him to the dry copper carbonate method of disinfecting wheat. He was of friendly disposition, being interested in people as well as things. He had a keen sense of humour and was a good conversationalist. Together with these personal attributes will be remembered his characteristic manner of smoking. He was fond of music, and his recreational interests included motor launching and fishing. He was a bachelor.

C.J.P.M.

Personal Notes

Wing Commander J. P. Ryland has been awarded the D.F.C. for courageous work at Ambon and later at a northern base. Wing Commander Ryland, who graduated in 1935, *resigned his position as assistant plant pathologist with the Victorian Department of Agriculture to become a commercial pilot with Ansett Airways Ltd.*

Mr. F. Hely, of the A.C.T. Branch, has been transferred temporarily from the Canberra laboratories of the Division of Plant Industry, C.S.I.R., to Huonville, Tasmania.

Dr. Allan Walkley has been seconded from the C.S.I.R. Division of Soils to the Division of Industrial Chemistry for the duration of the war. He began work in the Division's laboratories in Victoria in April, 1942.

Dr. I. F. Phipps has been seconded to the Flax Production Committee. He will undertake the coordination of investigations in Australia on flax. His headquarters are at present in Melbourne.

Messrs. H. K. Lewcock and G. D. Hubble have been transferred to Ayr, on the Burdekin Cotton Scheme.

Mr. S. T. Blake, a Commonwealth Research Fellow, has been seconded to the Department of Agriculture and Stock, Brisbane, for special duties.

Mr. A. A. Ross has taken up duties as Industrial Hygiene Officer with the National Department of Labour.

Recent enlistments with the A.I.F. from the New South Wales Branch include Messrs. R. O. Wilson, W. S. Sutton, B. Doman, A. N. Johnstone. Messrs. H. P. Brown and W. J. Webb are Royal Air Force reservists.

Mr. J. M. Vincent has been appointed Secretary to the Research and Experimental Section of the Department of Home Security.

Messrs. A. R. Woodhill and R. N. McCulloch have been appointed for entomological work, with the rank of captain, to the A.M.F.

A number of officers of the New South Wales Department of Agriculture have been transferred from their usual Divisional work in recent months. Mr. W. L. Morgan, Dr. E. T. Edwards, and Dr. S. L. Macindoe are now engaged in the vegetable growing project. Mr. H. P. Brown has been transferred to the Division of Extension and Information and Dr. F. T. Bowman seconded part-time to that of Agricultural Economics.

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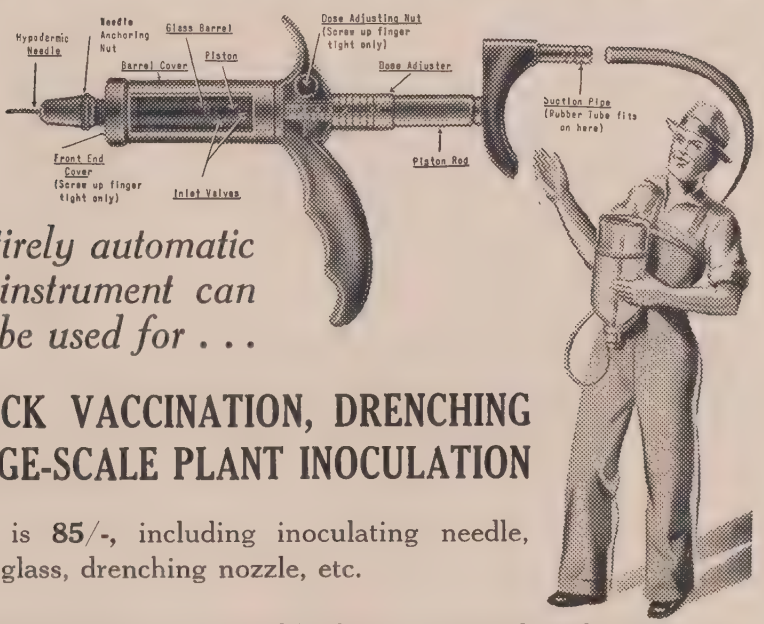

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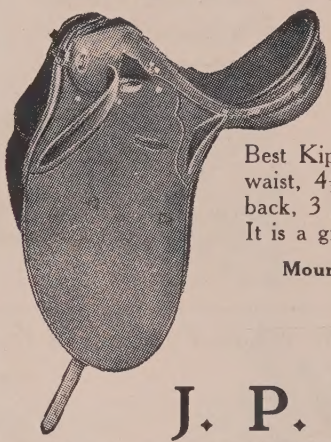

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That in turn makes available the planning ability of an industry, long famous for getting things done, to organise and put into operation new plants for volume production of tanks, aero engines, guns, shells, bombs, and other essential equipment.

As an example, one new G.M. American plant on tank production is now 7 months ahead of schedule—it produced its first 31-ton tank in 47 days.

That, today, is the General Motors story in Australia as elsewhere . . . no motor cars for civil use, but an ever-increasing flow of weapons.

Who Develops Industry Serves Australia

GENERAL MOTORS – HOLDEN'S LIMITED

Brisbane Sydney Melbourne Adelaide Perth

In these announcements, published from time to time, we are telling some of the war-time activities of General Motors in Australia and overseas.

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